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SOILS, CHEMICALS, IRRIGATION, ENGINEERING AND ECONOMICS

VOLUME 4, No. 3 MARCH 1952

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WORLD CROPS

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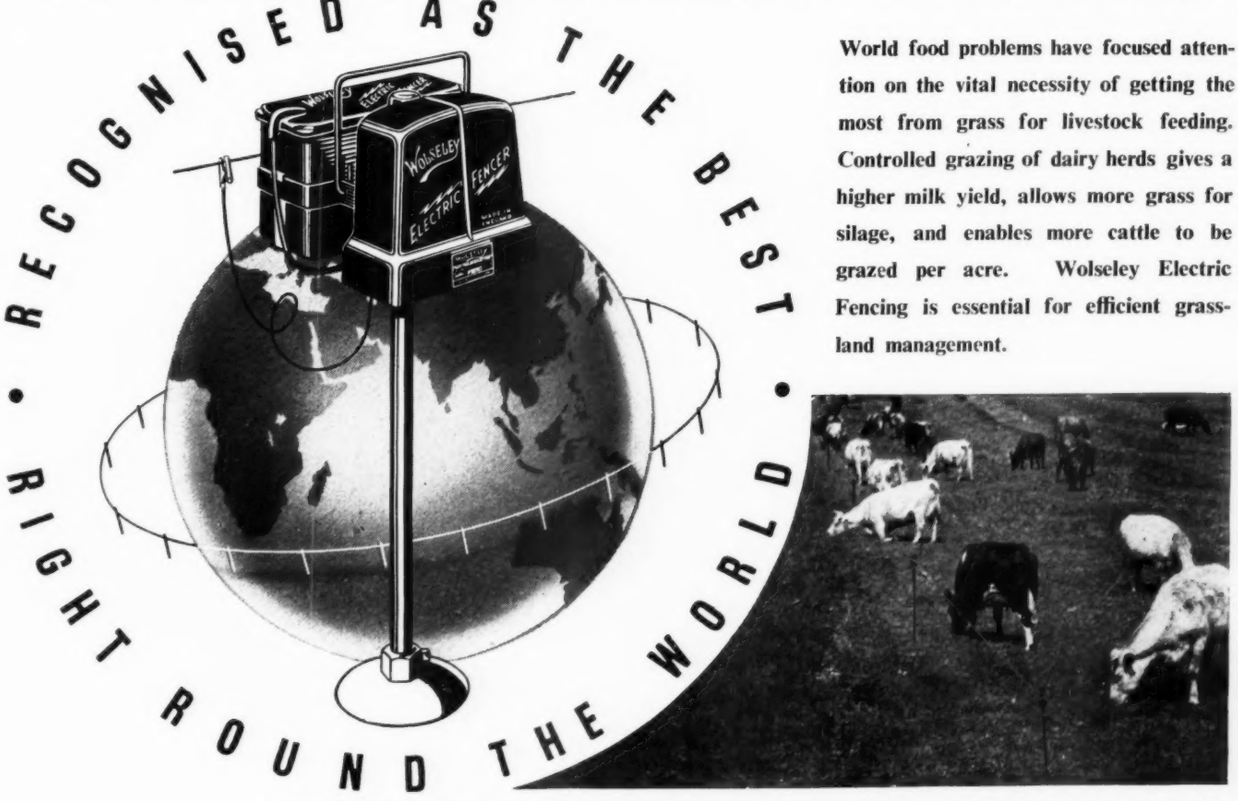

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Editorial Comment

WORLD CROPS and its readers share the universal grief at the death on February 6, 1952, of H.M. King George VI, so greatly beloved and respected by his subjects. His Majesty's practical contribution to British farming will long be remembered.

Commonwealth sugar

THE signature on December 21 last of the Commonwealth Sugar Agreement by the U.K. Minister of Food, Major Gwilym Lloyd George, and the representatives of the sugar industries of Queensland, South Africa, Mauritius and the British West Indies brings to a conclusion a series of negotiations which have been in progress for over two years. They started in 1949 when the British Government formulated proposals to replace the arrangements made during the war whereby the Government agreed to find an outlet for all Commonwealth sugar, surplus to local requirements. The arrangement was extended till January 1, 1952, so that by the time agreement was reached the matter had become one of some urgency.

There was much criticism and dissatisfaction in some of the Commonwealth countries, notably the West Indies, with the original proposals and it is all to the good that apparently agreement has now been reached on a scheme which is acceptable to all parties.

Perusal of the scheme shows that it is mainly in matters of detail that modifications have been made and that the principles involved are substantially those of the original proposals.

Details of the scheme

ESSENTIALLY the various territories have agreed to limit their total annual production of sugar to 2,375,000 tons. Up till December 31, 1952, the United Kingdom will purchase at an agreed price all sugar produced without limitation. Thereafter purchases will be limited by a quota of 1,640,000 tons and prices will be negotiated annually, the basis being the 1950 price of £30 10s. 0d. per ton, the actual price being arrived at by taking into consideration basic weighting cost figures supplied by the different territories. There is provision for the upward revision of the basic overall quotas in 1953 and subsequently, while deficiencies in any year from any one territory will be shared among the others, and from 1953 if the unrestricted domestic consumption of sugar in the United Kingdom exceeds 2,550,000 tons the Government will offer to increase the negotiated price quotas by at least the same percentage as the excess.

It further provides that in the event of a new international sugar agreement being negotiated none of the contracting parties will adhere to it unless the basic overall export production quotas quoted above are accepted as irreducible.

We commented on this matter in these columns just two years ago. We then expressed the hope that before long a solution would be reached, in view of the considerable measure of economic stability that in principle such an arrangement offered. It has taken longer than we expected to arrive at an agreement, but let us hope that now it has been achieved it will prove entirely workable and satisfactory.

Cocoa in the Gold Coast

READERS will remember that as the result of the changes in the Gold Coast constitution, the campaign for the compulsory cutting-out of cocoa attacked by swollen shoot disease was stopped for political reasons and it was decided to rely for the future on voluntary efforts coupled with the maintenance of inspection. At the same time it was also decided to stop cutting-out altogether in the intensely infected areas in the Eastern Province and to isolate them by a *cordon sanitaire* from lightly infected areas, in the hope that the disease would in due course destroy all the cocoa in the intensely infected area and that thereafter rehabilitation might be successfully undertaken (see WORLD CROPS, Vol. 3, p. 421). It was also hoped that by the use of the newly discovered systemic insecticide Hannane it might be possible effectively to check the mealy bug which spreads the disease. Recent reports from the Gold Coast for the period ending September 30 last seem to indicate that this new deal may be having somewhat disappointing results; in the lightly infested areas surveys and resurveys have been continuously carried on, and many new centres of infection have been discovered but only a very small proportion have been treated. Thus in Ashanti during September, 99 small outbreaks were apparently recorded, but it was only possible to treat seven of these leaving at the end of the month a balance of 92 cases untreated.

The Outlook

ON the other hand, curiously enough in the Eastern Province where treatment has been suspended, farmers are reported to be greatly disappointed and have appealed to the Minister.

Great hopes continued to be entertained of the results of using Hannane; it is understood that

supplies of it packed in capsules for ready application are coming forward in increasing quantities. The results of experimental applications have been strikingly successful, but the effects of its use on a country-wide scale still remain to be seen.

In any case the occurrence of large numbers of untreated outbreaks must give cause for anxiety; it would also seem that the Gold Coast farmers as a whole have not yet fully appreciated the essential importance of treating new outbreaks as soon as possible after their discovery.

In view of the extremely serious nature of the threat to the cocoa industry on which the whole prosperity of the Gold Coast largely depends, one cannot help wondering whether the Gold Coast Government were entirely well advised in abrogating altogether powers of compulsory cutting out while the threat to the industry continues unabated, notwithstanding the cogency of political arguments.

Libyan developments

THE recent attainment of self-governing status by Libya focuses attention on the agricultural problems of that dry and desiccated region. During the Italian occupation considerable efforts were made to develop agriculture; the grandiose land settlement schemes undertaken under the Fascist regime and aimed at settling large numbers of Italian immigrants on the land produced the beginnings of results, but with the end of the war and the termination of Italian occupation the problem of helping the development of the country in the interests of the Arab population has been given increasing attention.

For some time past an FAO technical assistance mission, under the direction of Mr. O. J. Wheatley, has been at work in Libya and a number of reports have come forward summarising and reviewing the position and the primary development needs which can serve as a basis for future action.

The problems of the region are twofold, *viz.* (*a*) those due to the country itself and the limitations imposed by physical conditions and (*b*) those arising out of the inherent characteristics of the Arab population.

Of those under (*a*), the most outstanding is the paucity of water and in Libyan conditions irrigation development must be assigned the number one priority.

Under (*b*) probably the most important is the improvident character of the arab farmer; others are defective land tenure systems and the need for investment capital and credit.

The water problem

THE underground water resources in Libya are limited; it has been said that there are probably more oil wells in Texas than there are water wells in Libya, and, in fact, the latter are so scarce that often a number of individuals may own a single well.

It seems not beyond the bounds of possibility that ultimately legislation may have to be enacted to limit the amount of water a single well may bring to the surface, for with growing use of underground water resources the water table begins to fall and the risk of depletion and salting by infiltration increases. It is on this account necessary to protect those who use and develop underground resources from over-utilisation. In any case, before development of water can occur ownership rights must be recognised and adequately protected, and this applies to both underground resources and surface supplies. In regard to surface water, the FAO mission recommended legislation to provide for ditch rights of way, regarding this as specially necessary for larger irrigation projects where water may have to traverse properties not owned by persons using the water.

Obviously there will have to be a lot of legislation and regulation enactment in Libya before sufficient water can be made available to bring the parched land into flower.

The Oxford Farming Conference

THE sixth Oxford Farming Conference held in December had for its principal theme the question: How far is it possible to step up agricultural production in Britain to meet the exigencies of the present economic crisis ?

Many speakers emphasised various problems and called attention to difficulties which must be overcome if the demand is to be met. Among the points that emerged is the impossibility of treating agricultural industry on the same footing as manufacturing industry. In a highly industrialised country such as Great Britain, with political power largely dominated by industrial interests, it is perhaps inevitable that agriculture should be regarded in many quarters as capable of subjection to the same disciplines and controls, particularly of labour as applied in urban manufacturing conditions. Such a view disregards, however, the fact that agriculture requires at certain critical seasons long hours of labour and above all a measure of critical awareness and keenness on the part of the labourer on the job and a versatility far exceeding in the aggregate that demanded from a factory worker.

This point must be taken into full account in plans for increasing agricultural output, and at a time when the accent is on defence expenditure, it must always be borne in mind that in a defence programme high agricultural output should be assigned a high priority.

Farming and Finance

MOREOVER, while all are agreed that increased output is essential, this can only be achieved by increased expenditure. High farming requires high finance. It is very well for the Chancellor of the Exchequer to say that ' defence needs make it imperative to check capital expenditure of all kinds, including expenditure on agriculture,' but in the last resort capital expenditure on increased production of essential food is just as much a defence item as is the capital expenditure on guns, tanks or explosives. It is an evidence of lack of vision to argue otherwise, for in the last resort what avail would be the possession of ample supplies of military material if the food which is needed to sustain those who have to produce and use them should become insufficient ?

At the conference the point was posed, ' can high farming pay ? ' Figures produced indicated that provided sufficient capital is available the answer is in the affirmative. On the other hand, the results of recent studies at Reading University indicate that every increase of £100 in farm output involves additional capital expenditure of £65.

By putting points such as these into perspective the conference has performed a valuable service and let us hope that they will be heeded in high quarters.

Alternative phosphatic fertilisers

INTEREST continues to be centred on the production of alternative forms of fertiliser to superphosphate consequent on the prevailing shortage of sulphuric acid. The matter formed the subject of a discussion at a meeting of the Agriculture Group of the British Society of Chemical Industry recently, when the subject was reviewed by Dr. Rice Williams and Mr. T. P. Dee. In particular, the partial substitution of nitric for sulphuric acid in the treatment of mineral phosphates has attracted much attention both in the U.K. and in the U.S.A. and numerous trials have been made and are in progress in both countries with material prepared by various processes. Trials have included both the so-called nitro-phosphates as well as other materials, including potash as well as nitrogen. For example, it is reported that granular fertilisers of good physical properties have been manufactured from rock phosphate, anhydrous ammonia, nitric acid, phosphoric acid and potassium chloride.

Recently, results in the south-eastern States of the U.S.A. have been summarised by Howard Rogers who states that the dinitro-phosphates, as they are termed in the States, have given satisfactory results with a wide range of crops. In the U.K. completed results have not yet come to hand; they are expected in the course of the next 12 to 18 months when the position should be clearer.

In the U.K. it has been suggested that manufacturers have been somewhat slow in translating these new ideas into commercial manufacturing practice, but it must be remembered that their introduction would involve heavy expenditure in the way of provision of new plant, and manufacturers are naturally unwilling to incur this until agricultural experts have given clear guidance as to the best type of fertiliser to produce.

On the other hand, the possibilities of successfully using nitric acid to replace sulphuric acid in manufacture appear so very promising that there seems to be a clear case for undertaking developments on at least a pilot plant scale.

Earthmoving by air

APROPOS of the articles on aircraft in agriculture in our December issue, our contemporary, the *Muckshifter and Public Works Digest*, comments in its January issue on the possibility of employing aircraft in earthmoving operations, pointing out that ' the distribution of manures and top-dressings by aircraft in agriculture is the operation nearest to earthmoving in civil engineering and, although concerned with smaller loads . . . it yet gives some indications of the possibilities.' The writer goes on to point out that these are greatest where it is required to deposit earth on sites difficult of access from the ground or where surface conditions make transport by vehicles arduous or impossible. It gives two examples where earth movements by helicopter have actually been employed in the United Kingdom, one in the case of a dam on a remote mountainside in Caernarvonshire and another on reclamation work in the Wash.

Obviously the only type of aircraft that could be used effectively for such work is the helicopter, but with improvements and development of this type of machine the possibilities may be not inconsiderable, not only in civil engineering operations as usually defined, but also in agriculture itself.

Particularly is this the case in relation to mechanised rice cultivation, where the levelling of the land to secure even distribution of irrigation water is oft-times arduous and costly by reason of the wet conditions. As our contemporary remarks, a helicopter which can pick up the earth without being troubled by the surface mud and drop it wherever it is wanted might well turn out to be the ideal solution. The determining factor is, of course, the cost, but with shortening labour supplies and improving aircraft design who would say that this definitely rules out the possibility of the ultimate employment of aircraft for work of this kind?

N. I. Vavilov

THE publication by the Chronica Botanica Co. in the U.S.A. of a translation of selected writings of the celebrated Russian agricultural

scientist N. I. Vavilov (reviewed on another page in this issue) calls for a brief reference to the life and work of this remarkable man.

Vavilov's work on the geographical origin of crops and his plant explorations in many countries to find new genetic material for breeding are widely known. He played a leading part in extending the possibilities of crop breeding, and his influence has been world-wide. As a staunch upholder of Mendelian genetics he was the unfortunate victim of the rise of the Lysenkoists whose dogmatic assertions have become a part of Soviet dialectic materialism. He was dismissed from the presidency of the Lenin Academy of Agricultural Science in 1938 and in 1940 from his post as Director of the Institute of Plant Industry. In the latter capacity he had established and directed over 400 agricultural research institutes and experiment stations in Russia.

According to reliable authorities, Vavilov was arrested in 1940, and died during the early 'forties in Siberia. Among those who believe that science should be the pursuit of truth as far as possible free from the distortions of personal rivalries and political expediency, Vavilov will always be held in honoured memory as a great biologist who linked several fields of knowledge in the service.

2,4-D and MCPA

THE relative phytotoxicity of 2,4-D and MCPA was discussed at a recent symposium organised in London by the Crop Protection Panel of the Society of Chemical Industry. These two selective herbicides are now extensively used in cereal and other cultivation in the U.K. and the U.S.A.; in the U.K. Methoxone is preferred, the consumption in 1950 being approximately 1,800,000 lb., while that of 2,4-D was 360,000 lb. In the U.S.A., on the other hand, the consumption of 2,4-D far exceeds that of MCPA, being about 10 million lb.

It was agreed that both compounds were about equally effective in their toxicity to annual weeds, but the toxicity depended to an extent on the intervals between sprayings, the incidence of rain after spraying, the concentration at which the compounds were applied and the salt used.

Serious damage by both compounds to cereal crops were stated to be very rare, the main manifestations of toxicity being malformations and yield reductions.

An interesting point raised was whether the use of these and similar growth-promoting substances as herbicides could affect the protein content or increase the growth of cereals. It was stated that claims had been made that increases of protein yields in wheat had followed applications of 2,4-D in the U.S.A. It was also pointed out that it was definitely established that the presence of plant growth regulators, which were foreign molecules within a plant, could alter the distribution and composition of normal constituents.

It would, accordingly, be a matter of great economic importance if it was possible to increase the nutritive value of fodder and other crops by the application of small quantities of growth-promoting substances.

The International Rice Commission

IT is announced by FAO that the International Rice Commission, which took its rise from the Baguio Conference on rice supplies in 1948, will hold its third meeting at Bandoeng in Java from May 12 to 16 next.

This body, since its inception, has proved very active; by means of its two working parties on rice breeding and on fertilisers notable progress has already been made in attacking and co-ordinating work on the many problems which must be solved if rice is to benefit from the application of scientific methods in the same way as some other cereals, notably wheat, have done. Meetings of these two working parties will be held at Bandoeng prior to the meeting of the Commission, which will consider among other items the reports of both.

The Commission now comprises 21 members, including most of the eastern hemisphere and western countries in which rice is grown, the main exceptions being Japan, Italy, Spain and the ' Iron Curtain ' countries. It seems permissible to expect that with the establishment of peace with Japan her adhesion to the Commission may follow in due course.

The agenda for the conference is very wide and varied; it includes, in addition to the topic already mentioned, the production and distribution of seed of improved varieties, the reduction of losses of rice in storage, improvement of implements for rice cultivation, irrigation, grading and marketing of rice, economic incentives for rice production, statistical services, extension services and the training of technical staff.

It is, however, a trifle surprising that, in view of amount of the attention being paid to the large-scale mechanisation of rice growing in some tropical countries, this subject does not appear.

THIS MONTH'S COVER

A Caterpillar diesel D2 tractor pulls a K.E.F. sprayer in a 25-acre orchard in Kent, England.

Recent Strawberry Breeding in Scotland

ROBERT D. REID

*Scottish Horticultural Research Institute**

Strawberry growing in the United Kingdom has been much handicapped of recent years by the incidence of disease. The steps which have been taken to control these diseases by the Scottish Horticultural Research Institute are described below.

INTEREST in the raising of new strawberry varieties probably began in the eighteenth century and since then many thousands of new varieties have been introduced in Europe and America. During the nineteenth and the first quarter of the twentieth century most of the breeding was carried out by private individuals, such names as Keen, Knight, Laxton and Bradley coming immediately to mind. In the early days of strawberry breeding, size and flavour were the main requirements when the fruit was intended for local consumption. With the development of long distance transport to large centres of consumption, varieties had to be selected which stood up well to transport and could reach the consumer in a satisfactory state.

Shortly after the first world war conditions arose which completely changed the strawberry growing industry and brought in new needs and new objectives in breeding.

The effect of disease

During the period between the two world wars the strawberry industry was devastated by a number of diseases, which singly or in combination made strawberry growing quite unprofitable in the majority of cases. Most of the older varieties became completely riddled with virus diseases, and in addition many plantations were seriously affected and in some cases actually killed out by fungus diseases. Other pests such as eelworm, aphids and mites also caused serious difficulty.

In general the approach to controlling these troubles has followed different lines according to their nature. Much has been achieved towards the control of insect pests by the use of chemical sprays; the virus diseases are kept under some degree of control by propagation, under conditions of strict isolation, of clonal stocks raised from single plants which have been virus-tested, these stocks afterwards being distributed to commercial growers. To obtain them it was necessary in some cases to secure stock from an outlying district where it had no chance of contamination, whilst in other cases new varieties have been raised from seed, the strawberry viruses not being seed borne. Thirdly, new varieties have been bred as part of a deliberate policy to raise varieties resistant to or immune from certain diseases or pests. A number of private breeders have continued to raise new varieties but gradually this field of work has been taken up by research stations or similar institutes.

In America there are many strawberry breeding projects, supported by government funds, which have the object of breeding for special purposes such as resistance to certain diseases or pests or to frost damage. In Great Britain during the past 20 years, while some private breeding of strawberries has taken place, the best known work is that done by Mr. D. Boyes at Cambridge and at Auchincruive by the Department of Agriculture for Scotland in collaboration with the West of Scotland Agricultural College. The writer[1] has been in charge of this latter project and it is intended in this article to give a short account of it.

Historical

In the period following the first world war the intensive strawberry growing industry in the west of Scotland, centred in the Clyde Valley, suffered very severe losses and on most commercial holdings strawberry culture became almost impossible. Early work by Alcock and Howells[2] showed the main cause of loss was a root rot which they named Red Core Root Rot. Alcock attributed this to a new species of *Phytophthora*, later named by Hickman[3] *P. fragariae*. Hickman.

Preliminary attempts to secure control by soil treatments and similar methods failed, but some small scale breeding work by members of the staff of the West of Scotland Agricultural College indicated that resistance to the disease might be obtainable, and in 1933 a systematic programme of breeding was started. As the work progressed it was found that the combination of disease resistance with valuable commercial qualities was elusive and called for much more intensive effort

First stage of propagation in producing a clonal stock from a single virus-tested plant

* *The work deserved in this paper was carried out by the Strawberry Disease Investigation Unit located at the West of Scotland Agricultural College, Auchincruive, under the aegis of the Department of Agriculture for Scotland and financed by the Agricultural Research Council. This unit although still located at Auchincruive and using facilities kindly provided by the College is now an integral part of the Scottish Horticultural Research Institute which has its main experimental farm and research laboratories at Mylnefield, Invergowrie, near Dundee.*

than had been anticipated. Moreover the recognition of the importance of other diseases and pests as factors in strawberry degeneration added complexity to an already difficult programme.

The work therefore had a threefold approach, and can be reviewed from the following three aspects:—

Resistance to Red Core Root Rot.

Incorporation of valuable commercial qualities.

Maintenance of selections in health and their propagation free from virus or other diseases and pests.

Resistance to Red Core

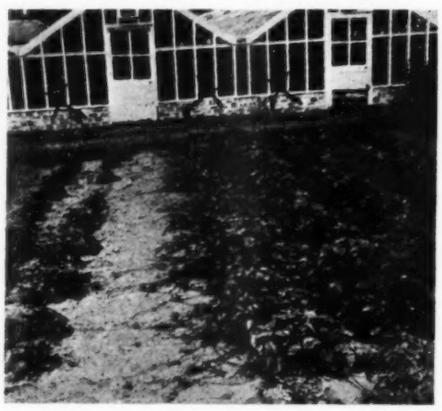
When the work was initiated the causal organism (*P. fragariae*) had not yet been grown in pure culture, and subsequent work has shown that it is only with difficulty that pure cultures can be established and maintained. As the work aimed at developing a practical control for the commercial grower, the methods of testing for resistance employed were confined mainly to the use of a natural inoculum, *i.e.* by growing seedlings in heavily infected fields, supplemented where necessary by pot inoculations under glass using, in some cases, soil from infected areas or, where more specialised results were required, pieces of infected roots from specific plants.

Early work

Early varietal tests showed considerable variation in apparent susceptibility, but closer observation indicated that some cases of resistance in the field were due to a slower rate of collapse or a more rapid recovery from attack due to the rapid production in the spring of new roots. Experience showed that such apparently resistant varieties did not transmit real resistance to families of seedlings raised from them.

The first variety to show genuine resistance was a selection in the trials labelled No. 52. It was believed to be a strain of a somewhat obscure variety called Frith. As the stocks were all infected with virus diseases and the variety is now obsolete, its precise identity can never be established. As far as can be ascertained Frith itself was a chance seedling whose parents were unknown. This No. 52 maintained complete immunity for the seven or eight years during which it was tested, but eventually infected plants began to appear. Families of seedlings raised from this selection by selfing and by crossing with named varieties yielded up to 37% of individuals which resisted infection when tested under field conditions, whereas

Infected with Red Core innoculum from different sources



Red Core disease; susceptible and resistant varieties

similar families of seedlings raised from other parents showed 100% infection. Selections from these resistant seedlings which had moderately good fruiting characters were developed and released into commerce as a temporary expedient until better varieties became available. (They were known as the 'Auchincruive' varieties; Nos. 1, 2, 4, 5 and 6.) Under commercial conditions these selections proved highly resistant, but after five or six years small localised areas were found where these plants were becoming infected. These local foci of infection gradually increased in number and area leading ultimately to a breakdown in resistance.

American work and its influence

Meantime American workers had found that a local American variety, named Aberdeen, also of unknown parentage, was apparently resistant to Red Core, and this claim was substantiated when the variety was tested under Scottish conditions. By using this American variety in combination with our own resistant types the proportion of resistant seedlings in many families was brought up to about 75%. Selections of these seedlings maintained their resistance in some cases up to 11 or more years. With very highly resistant selections breakdown does not usually occur until a variety has become widely distributed over hundreds of centres and experience shows that it starts in several centres simultaneously, in a year when climatic conditions are particularly favourable to the pathogen. First occurrences are in small localised spots where environmental conditions favour the rapid multiplication and spread of the causal organism. This development of breakdown in a hitherto resistant variety is very similar to the first introduction of the disease in a new area and its gradual spread follows a similar course.

More recent developments

In 1948 our most successful introduction, Auchincruive Climax, which had shown complete resistance throughout seven years of intensive testing, developed small patches of infection in a few widely separated centres. Rainfall in that particular year had been the heaviest recorded for over 30 years, being 9 in. above the average. In each case the infection was at first limited to a small area of bad drainage and appeared to spread from a central focus of infection.

Up to that time no satisfactory explanation of the cause of the apparent breakdown of resistance was known, but it was suspected that new biologic strains of the pathogen had arisen.

A number of inoculations were made using natural inoculum in the form of small portions of infected roots taken from different sources. Several varieties were used including new seedlings, some American resistant varieties and certain varieties reported as showing resistance in other areas. Amongst these Perle de Prague was of special interest since it has frequently been reported as being resistant to Red Core disease in Hampshire but had quickly become infected when grown in an infected field in the west of Scotland a few years earlier.

Recent results

In the tests carried out in the winters of 1948/49/50 inoculum was taken from several sources, *viz.*:—

1. Huxley, this being a sample from an ordinary commercial plantation which had gone down with the ordinary strain of the disease.

2. LR 19, a seedling of our own raising that, after a few years apparent resistance, had shown general susceptibility, being

heavily infected where an adjoining plot of Climax was free from infection.

3. Auchincruive 1, a variety whose resistance broke down after a number of years.

4. Ruskin, an old variety which had been the mainstay of the industry prior to the incidence of the disease, and which had gone out of cultivation.

5. Climax, from one of the very few centres where this variety had shown a small patch of infection.

Supplies of inoculum being very short in some cases, no attempt was made to test them on older varieties which had shown susceptibility under field conditions and in numerous earlier experiments. The object was to test specific strains of the pathogen on newer seedling selections or on varieties which were reputed to be resistant. Throughout, the common wild strawberry *Fragaria vesca* was used as a control since it is known to be very susceptible to Red Core disease.

The results (see table) showed a marked and specific differentiation in pathogenicity of the inoculum indicating that several strains of the pathogen existed and also that there was a marked variation in the intensity of symptoms produced, some strains being less virulent on ordinary varieties.

Interesting results were obtained by using inoculum from all three sources on a uniform batch of *F. vesca*. Inoculum from Huxley produced very severe symptoms, completely destroying the root system, leading to the early death of all the indicator plants. Inoculum from LR 19 gave a moderate infection of the root systems of *F. vesca* with some check to growth, but the plants showed good powers of recovery. Inoculum from infected Climax gave only a very slight infection of the root systems of *F. vesca* that did not materially check their growth and recovery was almost complete.

RED CORE DISEASE : POT INFECTIONS. NATURAL INOCULUM FROM SPECIFIC SOURCES

Source of Inoculum	*Varieties Infected*	*Varieties not Infected*
Huxley	*F. vesca*	Climax Tree Ettisburg New Seedlings :— No. 11 AES 23 AES 146 6J 4 6J 194 5F 80 6A 6
LR 19	*F. vesca* Perle de Prague Early Cambridge Un-named variety ex North of Scotland	Climax Temple Fairland Seedling No. 11
Auchincruive 1	*F. vesca* New Seedling 5F 80	Climax Seedlings :— No. 11 AES 146 6J 4 6J 194
Ruskin	*F. vesca*	Climax Tree Ettisburg
Climax	*F. vesca* Climax Early Cambridge Tree Ettisburg Royal Sovereign U.S. 3203 Fairland Auchincruive (1), (2), (5) and (6), infection very light—trace only New Seedlings :— 5V 117 5F 80 6H 70 6J 27 6J 92 6J 194 AES 23	Un-named variety ex North of Scotland (when repeated one plant became infected). Perle de Prague Temple Aberdeen New Seedlings :— 5C 32 AES 146 6A 6 6J 4

Strawberry seedlings at Auchincruive. Single plant units before selection

Strawberry seedlings at Auchincruive. Single plant units after selection

Conclusions

The conclusions drawn from these experiments are that new strains capable of infecting resistant varieties may arise at any time if environmental conditions favour rapid development of the pathogen in the soil, but that the specialised strains capable of infecting one resistant variety do not automatically attack other resistant varieties nor are they generally more virulent than existing strains. Each breakdown of a resistant variety acts in a similar manner to a new outbreak of the disease. Experience shows that by prolonging the time before infected land is re-planted, the risk of breakdown is greatly reduced. This procedure coupled with the use of resistant varieties makes strawberry cultivation possible even on heavily infected soils. From the breeding side, however, there is a strong and definite incentive to keep one step ahead of the disease rather than to obtain complete mastery over it.

In the actual breeding programme efforts are being made to include every possible source of resistance in crosses now being made.

Incorporation of valuable commercial qualities

However interesting it may be to the experimental biologist to obtain information on disease resistance, the commercial grower is not likely to be interested unless the plants produce fruit of commercial value. The large number of varieties introduced in the last 100 years, compared with the few which have survived for more than a few years, indicates that the production of an outstanding commercial variety is a rare event. When the combination of these desirable commercial characters with disease resistance is the objective, the chances of success seem somewhat remote. Any large batch of seedlings will present, to the superficial observer, many which attract attention because of one outstanding characteristic, *e.g.* vigour, promise of heavy cropping, fine quality fruit, etc. Critical examination, however, usually reveals many weaknesses. Of these the most common is unsatisfactory fruit texture. While the amateur grower or private gardener may be happy with a nice looking berry which has a good flavour and can be eaten shortly after picking, the commercial grower is necessarily much more critical in his demands. He must visualise the condition of the fruit when it appears in the retail shops perhaps 24 hours after picking and after having undergone the rigours of long distance transport. Moreover he must cater for the needs of jam manufacture, of quick freeze and of canning. If a variety can combine qualities acceptable for all these purposes, is a consistently heavy cropper, is resistant to one major disease and relatively free from infection by others it sets a very high standard indeed. Even this is not enough since it must ripen at a suitable season, be not unduly liable to frost damage and be suitable for growing under cloches. Above all, it must possess those intangible assets of having quality and being a "good doer."

To give some indication of the numbers of seedlings which must be raised before anything really good is produced it may be mentioned that shortly after the outbreak

of war, in the winter of 1939-40, we had on our hands approximately 14,000 seedlings. These were rigorously selected and discarded and only this year have we discarded the last of them. From this immense reservoir of potential varieties we have released only one—Auchincruive Climax!

Freedom from other diseases

While the idealist might suggest that the ultimate objective should be the production of varieties 'immune' from all diseases, no one with a knowledge of biology will consider this to be practicable. The best that can be hoped for is to present them free from infection by diseases and pests. The method of testing for resistance to Red Core disease whereby thousands of seedlings are grown fairly close together on heavily infected land is itself a source of danger. When the scope of the work was limited to supplying growers in local areas whose land was already heavily infected this did not constitute any serious difficulty, but with the growth of demand for plants from new areas where Red Core was unknown new problems arose. It was essential to avoid spreading the disease to new areas by means of infected soil adhering to the roots of resistant varieties, and care had to be taken to ensure that stocks were not affected by virus or other diseases or pests.

As a result of work carried out at East Malling[5] and elsewhere it is now well known that strawberry plants may be infected by several different viruses, either singly or in combination. Some varieties may be 'tolerant' of infection and, although showing no symptoms themselves, can nevertheless be potential sources of infection to other more 'sensitive' varieties. Moreover some varieties which show no symptoms when carrying a single infection may develop serious degeneration when infected by a complex of two or more. It is therefore highly desirable to avoid propagating selections that, even if apparently healthy, may be symptomless carriers.

The testing of stocks

It is now well known that the ordinary wild strawberry (*F. vesca*) is sensitive to all of the strawberry viruses known to be present in this country, and this fact has been used in the evolution of a system and propagation of strawberry stocks. After a variety has undergone several years' field tests and has given promise of possessing many desirable qualities combined with resistance to Red Core disease, a number of plants are lifted, potted up and removed to a glasshouse. There, stolons produced from them are grafted to indicator plants of *F. vesca* and if the results show the selection to be virus free, the runners from this tested plant are allowed to root into boxes of uninfected soil. These runners in turn are propagated in isolation on land which has not previously grown strawberries, thus forming a virus tested clonal stock for ultimate distribution provided that parallel tests carried out on the original stock continue to prove satisfactory. This method has also been found to give a satisfactory control of eelworm, another widespread but less publicised cause of loss in strawberry growing.

Practical value

The value of this work can only be assessed from its effects on the industry. While the original objective of complete immunity from a major disease may prove unfortunately unattainable it has become possible to grow strawberries once again on land on which the crop had failed entirely for many years. With the better knowledge of the disease itself, growers can do much to avoid the conditions most likely to lead to the build up of new biological strains of the pathogen. Many factors, including economics and available labour supply, affect the rise and fall of the area under strawberries; nevertheless the incidence of disease is probably the main contributory factor.

The most valuable result from this breeding project up to date has been the production of the variety Auchincruive Climax. It was first released to the trade in 1947, a total of less than 50,000 plants being distributed in that year. Its rapid adoption by strawberry growers has been remarkable, and it is now estimated that in the West of Scotland this variety represents over 95% of the total area under strawberries and taking the whole of Scotland it is believed to occupy well over 80% of the total area. In 1914, before the incidence of these diseases, the acreage of strawberries in Lanarkshire was 1,400; by 1943 it had dropped to 248 and by 1950 it had risen to 407. Taking the whole of Scotland the figures for the same years were: 1914, 3,000; 1943, 815; and 1950, 1,718. The variety has also been extensively adopted elsewhere, and in some parts of Northern Ireland it is practically the only variety grown. It is, moreover, rapidly increasing in favour in many parts of England where it is displacing Huxley, for many years the most extensively grown variety, simply on its merits of cropping and quality. Many reports have been received of crops of four tons per acre and over on large commercial holdings. It has established itself as the favourite of the commercial jam manufacturer, the canner and the quick freezer. In the fresh fruit market, it takes second place only to the deservedly popular Royal Sovereign which, raised nearly 60 years ago, is still unsurpassed in quality, but is so susceptible to Red Core disease that it cannot be grown in many areas. Some indication of the merits of Climax on quality alone may be obtained from the fact that in 1948 the Royal Horticultural Society gave it an Award of Merit and in 1950 a First Class Certificate, this being the first F.C.C. awarded to a strawberry variety for 37 years and only the fifth occasion when both awards were made to a strawberry variety.

Conclusion

The foregoing account will serve to show some of the problems facing the strawberry breeder and how they are being tackled at one centre. There can obviously be no finality of the achievement and the work must be continually re-orientated to meet new conditions and needs. Efforts are being made to produce commercially acceptable varieties possessing factors of resistance to the known new strains of the pathogen and ripening at various seasons, so as to provide varieties earlier and later in ripening, thereby extending the picking season.

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WORLD CROPS

OUR NEXT ISSUE will be partly devoted to **the rice industry** and articles dealing with this subject will include :—**Mangrove Reclamation for Rice Growing,** by Hector Macluskie, **Experiments with Fertilisers and Soil Amendments on Rice** and **The Improvement of Upland Rice.** Rotary cultivation and the work of Messrs. **Rotary Hoes Ltd.,** will be the subject of the April article in our series **Industry's Contribution to Agricultural Research.** The issue will, as usual, carry other articles and regular features—research developments, book reviews, etc.

(*Left*) **Rainfall in this north-eastern region of Tennessee sometimes reaches 80 in. a year. A vegetative cover on the watershed will be planted to reduce surface runoff.** (*Right*) **The result of 150 years of cultivation, deforestation and heavy rains; new farming methods and water control are needed to rehabilitate the land**

Rainfall, Watershed and Stream Flow

With Illustrative Data from the Tennessee River Basin, U.S.A.

HARRY A. CURTIS

A director of the Tennessee Valley Authority

This is the second part of Dr. Curtis' article, the first part of which appeared last month. In it he discusses details of the disposal of water falling on a watershed and the possibility of affecting the yield of water by varying land use.

IN speaking of the rainfall on a watershed it is the custom to state the mean for a long period and to express it in inches per year, as though the rain were evenly distributed over the whole area. Actually the rain is not distributed evenly and the quantity per year varies. For example, the average rainfall in the Tennessee River Basin over a 60-year period is about 51 in., but the actual rainfall varied from about 26% below to 23% above the average figure. Moreover, the averages for various parts of the valley are appreciably above and below that for the valley as a whole. While the long-period average rainfall is useful in some ways, it does not contribute significantly to an understanding of the relationship of the watershed to the streams.

As a long-time average, about 42% of the water that falls on the Tennessee River Basin leaves by drainage.

Rainfall and stream flow

If, however, one turns to the yearly record of rainfall and stream flow it appears at once that in a relatively dry year the streams receive much less than the average 42% of the water, and in a relatively wet year much more. The variation in stream flow is greater than the variation in rainfall. This lack of co-ordination between stream flow and rainfall is even more striking when one considers the monthly records for a single year. There are normally a few months of relatively dry weather in the autumn when the water reaching the streams falls to a minimum. In December, when the rainy season normally begins, the streams rise and continue to rise during January, February and March. The main stream reaches flood stages only during this period, when the multi-purpose artificial reservoirs of the area are drawn down to low-pool levels after each storm, so as to provide water storage and reduce flood crests. In years of normal rainfall the flow of water decreases during the spring months and continues to decrease all through the summer, despite the heavy rains that usually come in June and July. This is shown in the rainfall-stream flow curves of Fig. 1.

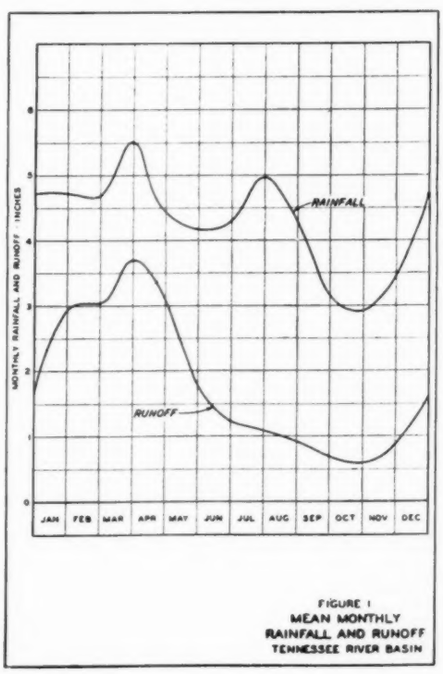


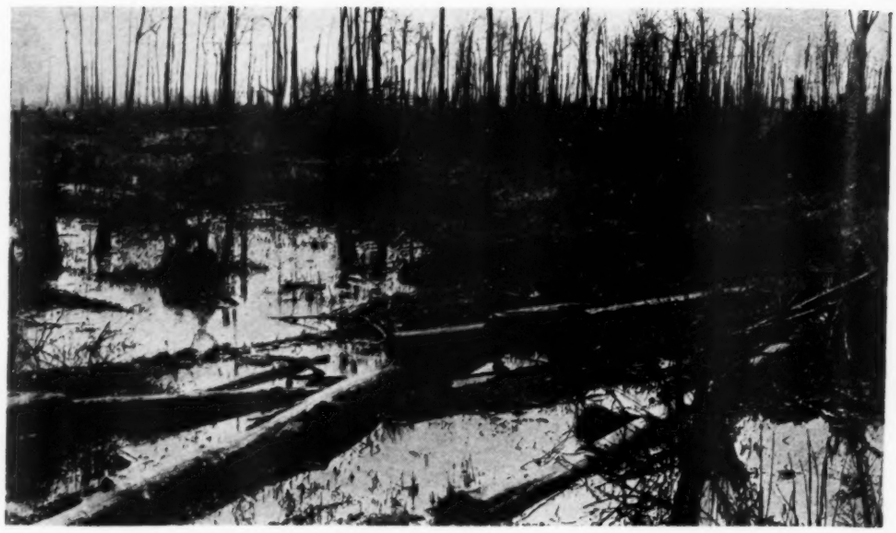
FIGURE 1
MEAN MONTHLY
RAINFALL AND RUNOFF
TENNESSEE RIVER BASIN

An explanation of the fact that stream flow does not correspond closely to rainfall lies, of course, in the changing conditions in the natural reservoirs. Rainfall and stream flow per year or per month are expressed in unit quantities of water per units of time and are therefore rates. This matter of rates of water movement is of much importance in the relationship of rainfall, water reservoirs and stream flow, particularly when rates over shorter periods of time than years or months are considered.

Infiltration

When rain begins to fall on a watershed, the surface of the vegetation is soon wet, *i.e.* this natural reservoir has a small storage capacity and is filled by a small amount of

rain. As rain water reaches the ground it begins to infiltrate. . Rates of infiltration differ widely for different soils and with different physical conditions in a given kind of soil. Moreover, the physical condition of a soil changes as water enters it; for most soils the infiltration rate falls rapidly during the first few minutes; if rain spatters on a soil, the soil aggregates near the surface may be dispersed and plug the macropores so that the rate of infiltration falls nearly to zero. If the rate of rainfall exceeds the rate of infiltration, pools of water form in the depressions of the ground and, as these are filled, surface run-off begins. How much soil erosion this surface run-off causes depends upon many factors, amongst which are land slope, rate of run-off, kind of soil, and the extent to which the soil is anchored by the natural cements present and by plant roots.



'So long as the ground surface remains wet, the rate of evaporation from the surface is fairly rapid'

Percolation

Closely tied in with infiltration is percolation, which is the downward movement of water through the macropores of the soil under the pull of gravity. As the water moves downward, it is picked up by the micropores of the soil as capillary water until the soil reaches its field capacity, thereafter all the water that infiltrates moves down to the water table. The movement of water from the macropores into the micropores is not a very rapid process and for this reason water may, for a time, percolate through a soil not yet at its field capacity for capillary water. Rates are again involved. Moreover, it is obvious that water can infiltrate only so fast as percolation can carry it away from the ground surface and, on the other hand, water can percolate only so fast as it moves through the surface layers; the two rates are interdependent and either may become the controlling factor as conditions change.

Water that reaches the sub-water table reservoir normally increases the quantity in the active storage range, and this water slowly moves to the streams, the rate being much slower than the rate of the surface run-off.

Evaporation losses

Capillary water is removed by evaporation at the ground surface and by the roots of plants, and here again rates come into play. So long as the ground surface remains wet the rate of evaporation from the surface is fairly rapid. Here the vegetation plays an important role, since by shading the soil it cuts off light that would furnish part of the energy necessary for evaporation; furthermore, the vegetation cover retards air movement near the surface, thus lowering the evaporation rate.

Transpiration losses

Once the surface of the soil is dry, however, relatively little water moves upward to the surface, for it can only move as vapour and this process goes on very slowly. On a watershed supporting a vigorous vegetation, plant roots remove considerably more water than is lost by surface evaporation. Only a very small fraction of the water picked up by the roots of plants is utilised to build up plant tissue or to furnish plant sap. Most of it is carried to the myriad stomata on the plant leaves, when it evaporates by transpiration. Plants differ considerably in their 'water requirement' in the quantity of water withdrawn from the soil per unit of dry plant material produced. The range is from about 200 to about 800 lb. of water per lb. of dry plant matter for different kinds of plant, depending on the availability of water to the plant roots, the fertility of the soil, etc. Moreover, evaporation of water from the stomata is controlled by two groups of factors, one of which relates to the plant and the other to conditions that control evaporation, *i.e.* temperature, relative humidity of the surrounding air, etc. In any event, transpiration always accompanies plant growth and accounts for a large fraction of the water that falls on the watershed, but does not reach the streams.

Incidence of rain

The relationship of a watershed to its streams involves not only the quantity of rain per year or month and its distribution through the seasons of the year, but also the precipitation rates over short periods during rainfall. As already mentioned, surface run-off occurs whenever the rate of rainfall during a storm exceeds the rate of infiltration by more than enough to fill the small ground surface depressions. The rate of precipitation is seldom constant throughout a rainstorm. There are usually bursts of heavy rainfall spaced by intervals at moderate or low rates. In the Tennessee Valley the summer rains are characteristically of short duration with heavy bursts at or near the beginning of the storms. These storms are normally limited to small parts of the watershed at any one time, but they cause a high rate of surface run-off and consequent difficulty in preventing excessive soil erosion.

Summer conditions

During the summer months the soil moisture is usually far below field capacity and the soil will absorb all the rain if it comes slowly, and not in heavy outbursts. The rain that infilters is mostly taken up as capillary water and does not reach the streams. Furthermore, the volume of surface run-off is not large.

During the late summer, when the leaf surface of deciduous trees is at its maximum, interception of rainfall is at its peak and transpiration and evaporation from the ground surface also go on at relatively high rates. The net result is that little or no water can get through to the sub-water table reservoir and the watershed, which on a long-time average absorbs 58% of the rain, will during the late summer turn back to the atmosphere much more than 58% of the total. On small watersheds in the Tennessee Valley hydrologic measurements indicate that in some months as little as 10% of the rain reaches the streams.

Winter conditions

Records of water flow in the main stream of the Tennessee Valley indicate that the

river reaches flood stage only in the January to March period. Conditions are then quite different from those prevailing during the summer and autumn months. Rains are usually prolonged and often heavy. Evaporation from the ground surface is at a relatively low rate; rain interception by vegetation is at a minimum; transpiration is likewise at a minimum. The net result is that the soil reservoir fills, *i.e.* the soil reaches its field capacity and can take up no more water. Rain that infiltrates must percolate through the soil reservoir to the sub-water table reservoir and this normally fixes the percolation rate at a low level; since water can infiltrate only so fast as percolation carries it away from the surface layer of soil, the rate of infiltration also falls to a low level and the stage is then set for a high rate of surface run-off during heavy rains and the streams reach flood stages.

Vegetation cover cuts off light and retards air movement, thereby lowering the rate of evaporation

Influence of vegetative covers

It will be obvious that the vegetative cover of a watershed has a profound influence on the quality, quantity and rate of flow of water of the streams that drain the watershed. The surface of the vegetation provides one of the natural reservoirs that receive and turn back to the atmosphere a portion of every rain; the vegetative cover shades the soil from direct sunlight and lowers the rate of evaporation of water from the ground surface; it also lowers the rate of air movements near the ground surface and thereby again reduces the rate of evaporation. On the other hand, growing plants transpire moisture taken up by their roots, thus turning back to the atmosphere another portion of the rain. Vegetation also influences the physical structure and composition of the soil and determines to a marked degree the rates of water infiltration and percolation through the soil. The vegetative cover of a watershed is also the largest single factor affecting the incidence of soil erosion.

Effect of land use changes

It will also be obvious that changes in land use which alter the vegetative cover will be reflected in changes in watershed-stream flow relationships. So far as soil erosion is concerned, many quantitative studies of the effects of vegetative cover have been made, and it has been amply demonstrated that soil erosion can be reduced to tolerable limits through the protection a vegetative cover affords. Less is known of the effects of changes in land use on the total yield of water from a watershed to its streams, or the timing of water yield thereby induced. Some quantitative data (from a few experiments) are, however, available. For example, in the Coweeta Experimental Forest (North Carolina) of the U.S. Forest Service it has been shown that when all the trees and undergrowth on a small watershed are cut and left on the ground, and the sprouts cut from time to time thereafter, there is a 100% increase in water yield from the watershed in the August to October period and a 65% (17 in.) increase in the annual water yield, with no increase in surface run-off. While it is of interest in showing the role of vegetative cover in determining water yield, the Coweeta experiment, however, does not represent an economically feasible change in land use.

Typical of the mountainous region of Tennessee, where care must be taken to prevent runoff when the hillsides are cleared for cropping

Effect on hydroelectric power generation

Studies in the Tennessee Valley indicate that probably such changes cannot be justified solely on the basis of increased revenues from power generation through increased water yields induced by changing the vegetative cover. In the power system on the Tennessee River and its tributaries the total drainage area above the dams is 40,200 square miles and the average water yield of the watershed is 21.4 in. The total energy potentially available from the average annual water yield is 18,551,000,000 kWh. From these data one may calculate that if all the hydroelectric energy were to be generated at one dam, the head necessary would be about 465 ft. An acre foot of water moving through a 465-ft. fall, with 85% equipment efficiency, would generate about 405 kWh., worth 81 cents

per kWh. This provides a rough measure of how much might be spent annually per acre in order to increase water yield by 12 in. Inasmuch as the average water yield is 21.4 in. for the watershed as a whole, the 12 in. would represent a 56% increase; it is difficult to visualise any practical change in land use that would bring about so great an increase and, in any event, the relatively small return to be expected from the increase in hydroelectric energy yield would make it economically infeasible.

Effect on agricultural practices

Inasmuch as it appears to be economically infeasible to change the vegetative cover of a well-watered watershed for the sake of increased water yield and power supply, it remains to ascertain, if possible, what changes in land use are attractive from an agricultural standpoint and would at the same time improve the watershed-stream flow relationship. It is certain that there are a number of agriculturally desirable changes in land use that will lessen soil erosion. In the Tennessee Valley there is going on at present a considerable shift from intertilled crops, such as cotton, maize and tobacco, to pastures and a livestock agriculture. Grasses and clovers that grow well during the cool, very early spring months in the valley are now available, along with new varieties of so-called 'winter-growing' small grains. The shift from crops to pasture will reduce soil erosion and will improve the watershed-stream flow relationship. But when the question as to possible effects on the annual water yield or the timing of the water yield is raised there is a lack of reliable experimentally established data. This prevails not only with respect to the effect of the vegetative cover on water yield, but also with respect to reduction of soil erosion by contour ploughing, terracing, etc.

Fundamental factors

Any study of the relationship of a watershed to the streams that drain it reveals that a number of fundamental factors prevent the achievement of the ideal situation in which the vegetative cover prevents all surface run-off and yet permits a large proportion of the rain to reach the streams by underground flow. Obviously a watershed having an impervious rock mantle would deliver nearly all the rain to the stream, there would be no soil erosion problem, and every heavy rain would cause high stream flow. The only means of storing water during the rainy season for subsequent use in generation of power would be by artificial storage reservoirs. In the Tennessee Valley watershed the average annual rainfall is 51 in., the average yield of water from the watershed is 21.4 in. and the storage capacity of all the 30-odd dams in the normal operating range is only about 3.6 watershed inches. Obviously so small a storage could not do much in regulating stream flow if the whole 51 in. of rain reached the stream and were evenly distributed during the year. The storage reservoirs would have little significance and the dams would serve only to concentrate the waterheads conveniently for power generation. Even in the actual situation, where only 21.4 in. of the total 51 in. reaches the streams, it is obvious that the natural reservoirs of the watershed, rather than the artificial reservoirs, play the major role in determining stream flow.

A dense vegetative cover on a watershed is desirable in order to reduce surface run-off and consequent soil erosion. Absence of surface run-off indicates that conditions must be favourable for both infiltration at the ground surface and for percolation to the underground water table. Yet this same vegetative cover also intercepts rain and returns it to the air by direct evaporation; large areas provided by the leaves of the vegetation assist transpiration and they also return large quantities of rainwater to the air. In a well-stocked forest conditions for rapid infiltration and percolation are very favourable, and these factors favour water yield. But one need only consider the Coweeta experiment to realise the very heavy toll of rainfall taken by a forest.

Conclusion

Most of the experimental work on soil-water relationships has, until recently, been directed primarily to securing of information useful in agriculture and forestry. In the present paper the attempt has been made to examine also the relationship of a watershed to the streams therein, having regard to the use of the water and the production of hydroelectric power; it appears that probably the value of the increments in energy yield that could be achieved through changes in land use in a watershed would not be great enough to pay the cost of such changes and that accordingly changes in land use must be justified mainly on the basis of the benefits they confer on agriculture.

It will be recognised, however, that there may be cases where an increase in water yield from a watershed may be much more valuable than its worth as potential hydroelectric energy. In the United States at present scores of towns and cities are in need of larger supplies of water for domestic use. In these cases an acre-foot of water—nearly 326,000,000 gal.—may have a much higher value than that assigned to it in terms of potential hydroelectric energy. Accordingly, it is important to know, in quantitative terms, what changes in water yield from a watershed can be brought about by changes in the vegetative cover or by other means, quite aside from the value of such information in relation to hydroelectric power production.

Photos: U.S.I.S.

Sindri Fertiliser Factory

Production of ammonium sulphate, which began in India's Sindri fertiliser factory at the beginning of December, has now gone up to over 100 tons a day. In the first few days the output was only 10 tons daily.

Full production of 350,000 tons is expected to be reached by the middle of this year. This will help India save about £7.5 million foreign exchange, which is now being spent every year on imports of fertilisers.

A striking feature of the £17.25 million fertiliser factory is the number of gigantic plants and machines that have been installed and the colossal structures that have been erected. Some idea of the magnitude of the project can be had from the fact that the plant and equipment weigh 45,000 tons, besides 11,000 tons of steel used for structure work. To provide water for the dry months of the year a barrage is being constructed on a tributary of the Damodar river.

Colombo Plan Exhibition

The story of the Colombo Plan and its implications for participating countries will be told at an exhibition in Colombo from February 16 to March 16. In the United Kingdom pavilion will be illustrations showing her part in the Plan, including demonstrations of U.K. material resources and skill which are being made available for economic development. These will include, for example, a display of surveying methods for natural resources, provided by Hunting Aerosurveys Ltd., demonstrations of irrigation equipment, agricultural machinery, fertiliser use and power resources.

The U.K. dependencies in S.E. Asia will also have a pavilion at the exhibition, and, of course, Ceylon will have her own national pavilion which will show the country's economic and social progress during the last 21 years and plans for future development. Among other participating countries are Australia, Canada, India and Pakistan.

The 20-acre research station of Bayer Agriculture Ltd. at Crawley in mid-Sussex

INDUSTRY'S CONTRIBUTION TO AGRICULTURAL RESEARCH—III

Crawley Research Station

The Work of the Technical Department of Bayer Agriculture, Ltd.

In the third article of this series an account is given of the work of Bayer Agriculture, Ltd., which specialises in the manufacture of dressings for seed and other forms of planting material.

THE discovery of the organo-mercurial seed dressings and their introduction to the U.K. in 1928 were primarily responsible for the beginning of what is now the firm of Bayer Agriculture Ltd. The organo-mercurials were the first universal seed dressings to be used against all diseases carried on the seed coat of cereals such as bunt or stinking smut of wheat, the smut of oats, covered smut of barley and leaf stripe diseases of oats and barley.

Early developments

The operations of this company originated in 1928 in the agricultural department of Bayer Products Ltd., a firm specialising principally in pharmaceutical chemicals. No research work was then carried out in the U.K., but full service was obtainable from the appropriate department of I.G. Farben in Germany. During the 'thirties, however, a comprehensive agricultural advisory service was initiated and carried on in the U.K. under C. T. N. Wakely, B.Sc., and H. C. Mellor, A.R.C.S., B.Sc., with the help of a number of outside specialists who informed them of specific growers' problems in different parts of the country. Today, the free advisory service is one of the main departments at the Crawley Research Station in mid-Sussex, and close contact is maintained with the outside representatives.

After the war, in 1946, the 20-acre property at Crawley was bought and equipped with laboratories for chemical, plant pathological, mycological and entomological work. Prior to 1946 the land had been used for growing young conifers and much clearing work had to be done before experimental trial plots could be laid out. Now, 14 of the 20 acres are under various trials and a number of glasshouses are available for special investigations.

The organisation today

In July 1951 the agricultural department became a separate company, Bayer Agriculture Ltd., taking over the whole of Bayer Products' agricultural interests, including Crawley Research Station and a range of some 17 insecticidal, fungicidal, and weedkilling products. The Company is now under the managing directorship of Mr. Wakely, with Mr. Mellor as head of research and development. The Station is staffed by Mr. E. D. Wiggins, B.Sc., who is the senior plant pathologist and is in charge of the advisory service, and Dr. M. L. Bird, Ph.D., F.R.I.C., chief chemist, together with 14 assistants.

All the home technical representatives of the Company have a spell of training at Crawley before going on the road; there are also technical representatives who travel the country, advising and solving growers' problems, and a feature of the close contact between representatives and research is the continual liaison which is maintained with the staff at Crawley.

Overseas agents are, for the most part, firms in the same business and they often come and visit the Station as well.

Work at Crawley

At the Crawley Research Station work is divided into two sections, both based on the chemical laboratory. First, there is the continual search for and development of new chemical compounds; and secondly, is the work of servicing existing products.

The search for new compounds may be carried out in various ways. For instance, new compounds may be synthesised and new formulae devised, which are put through a sorting process in which they are tried against a selection of fungoid and insect pests. The reaction to each chemical is noted and in this way it is judged whether a new compound is worth further investigation in the field for possible commercial use.

More usually, however, the approach has been to a specific problem, an example being the work on dry rot of potatoes which led to the evolution of the com-

pound known as Fusarex, dealt with at a later stage in this paper.

A good deal of the servicing work carried out by the Company at Crawley consists of checking the performance of fungicides, etc., both chemically and biologically. In addition, all raw materials used in the various Bayer Agriculture Ltd. formulations are analysed and checked before being made up. This rigid scrupulousness is a legacy from the pharmaceutical days.

Organo-mercurials for seed treatment

Since the introduction of the organo-mercurial fungicides a continuous search has been going on for new organo-mercurial compounds with greater margins of safety and for new non-poisonous materials.

Originally, before organo-mercurials were introduced, solutions of copper sulphate or mercuric chloride were the only known treatments for seed-borne diseases. The first organo-mercurials for seed treatment were applied in liquid form and contained 18% mercury. Nowadays, these dressings are applied in the dry form and contain only 1.5% mercury, thus rendering them much less poisonous.

The advent of the dry dressings such as Bayer's 'Ceresan' has made disinfection of wheat seed safe; no damage to the seed or its germination can occur. The principle of this treatment is the churning together of the seed with a requisite quantity of the chemical in powder form in a closed container for about three minutes, so as to ensure that every grain is completely coated. Seed so treated can be sown immediately or stored without affecting its subsequent germination.

Placing Petri dishes of fungus cultures in an incubation oven

Bulbs, corms and tubers

After perfecting seed treatment, the Bayer research workers turned their attention to the treatment of bulbs, corms and potato tubers. Here dust dressings were found to be not quite so effective as solutions of soluble organo-mercurials, and the latter were chosen as the most practical method of treatment, since bulbs and tubers can be dried fairly easily.

As is the case with bulbs and corms, a number of diseases are carried on the surface of seed potatoes which cause considerable losses in the field during storage; they include dry rot (*Fusarium caeruleum*), gangrene (*Phoma foveata*), blight (*Phytophthora infestans*), skin spot (*Oospora pustulans*), common scab (*Actinomyces scabies*) and black scurf (*Corticum* (*Rhizoctonia*) *solani*). A treatment depending on immersing the seed tubers in a solution of the organo-mercury compound (Aretan) was worked out. Treatment is carried out within 24 hours of lifting and the tubers thoroughly dried in trays before clamping or bagging.

Sugar cane setts

Parallel with this work in the United Kingdom, investigations were carried out overseas on the treatment of sugar cane setts for planting to protect them against pineapple disease (*Ceratostomella paradoxa*) which is a fertile source of loss wherever sugar cane is grown. Early work in the West Indies had shown that treatment of the setts with lime suspensions or with Bordeaux mixture afforded some protection, but Dr. McMartin, working in Natal, showed that complete protection against the disease could be secured by dipping the setts in a solution of Aretan, an organic mercurial containing 3% mercury. On a plantation scale the dipping process is carried out by immersing a crate filled with setts in a tank of solution, using a small crane for the job. This method is a direct result of earlier work on dipping potato setts against scab.

Dry rot of potatoes

In 1939-40 Dr. Muskett, professor of botany at Queen's University, Belfast, and Dr. Foister, head of the Scottish Plant Pathological Service in Edinburgh, showed that 0.5% solution of Aretan was effective against dry rot, the worst disease of seed potatoes.

Although this method was effective in controlling the disease there were a number of practical disadvantages. Since the organo-mercury compound is poisonous the seed to be treated must be separated from the 'Ware' potatoes immediately after digging. Moreover, dipped seed must be dried thoroughly before bagging, a large quantity of boxes is required for storage and additional labour is needed for bagging the seed.

It was clear that in order to overcome all these difficulties it was necessary to evolve a dry method of disinfection.

The 'Fusarex' Story

Side by side with the dipping experiments, therefore, extensive work was carried out with a large number of chemicals in dust form, and in June 1947 the compound which has given the consistently best results was introduced under the registered trade mark, 'Fusarex.'

A research assistant collects pupae of the diamond-backed moth, bred on cabbage leaves for experimental purposes

The product, which is based on 2.3.5.6 tetrachlornitrobenzene, acts by slow volatisation, and there are indications that most of the effective ingredient is dissipated after six to eight months of clamp storage. The Fusarex itself, however, stores well in bulk and does not lose strength.

An additional advantage is that it effectively checks sprouting during storage while potatoes after storage are in a firm dry condition. A full account of the trials which led to the development of this compound appeared in a previous issue of WORLD CROPS (Vol. 1, p. 63, October 1949) and need not be repeated here.

Fusarex treated potatoes for export

A problem which has lately occupied the attention of the Crawley staff is the use of Fusarex for treating seed potatoes in-

tended for export. It has been found that certain consignments of Fusarex-treated seed potatoes started to sprout on board ship, due, it is thought, to the open type of crate used as containers for them. It is now believed that a suitable paper lining to the crates will prove to be the most economical solution to this problem. In this way the necessary ' closed storage ' will be obtained.

Growers' enquiries

Much of the work carried out at Crawley arises from enquiries received from growers, and several of the products of Bayer Agriculture Ltd. have resulted from these.

Pre-emergence damping off

For instance, Dr. Blair, a government plant pathologist in Canterbury, New Zealand, was experiencing trouble with pre-emergence damping off of peas; that is, the rotting of seed below ground due to the activities of soil fungi. A fungicide

Mr. E. D. Wiggins, Senior Plant Pathologist, examines cucumbers for the development of mildew, which will be treated

was required which would be cheap and also obtainable in the sterling area. Although some organo-mercurial would have done the job, it was found that thiuram was equally effective and had the added advantage of being non-poisonous; accordingly, the latter was chosen and is now marketed under the name of ' Premasan.'

Tulip fire

Another enquiry which led to the formulation of a non-poisonous powder fungicide effective against certain soil-borne diseases of bulbs and corms came from tulip growers, park superintendents and others who grow bulbs in the same soil year after year.

In this case another chlorinated nitrobenzene was found to be effective against tulip fire (*Botrytis tulipae*), grey bulb rot of tulips (*Sclerotium tuliparum*) and similar diseases affecting gladioli and narcissi. Before this fungicide was introduced the soil in park flower beds where tulips were grown had to be taken up and replaced with fresh material each successive year; 400 sq. yd. of soil cost £530 to take up and replace. Now with Botrilex (the name given to this chlorinated nitrobenzene fungicide), distribution of the powder and raking it in costs £21 for the same area.

Current investigations

At present investigations are proceeding on a possible fungicide to kill the underground mycelium which causes fairy rings on turf—again as a result of enquiries from park superintendents.

Other work on potatoes includes the investigation of possible haulm destructors in substitution for sulphuric acid, which is now in short supply. So far, tar oils have been found to possess possibilities in this direction.

Conclusion

Plant pathological research as carried out at Crawley is an exacting and highly technical business. Continuously the search goes on for new fungicides and new ways of applying them. No longer

Smutted and healthy heads of oats; seed dressings are tried out on the naturally infected seed

are materials merely by-products of other branches of industry; they tend in an increasing degree to be ' tailor-made ' to fit the particular diseases it is sought to control.

The work is slow and laborious and practical results appear often only after a protracted period. But the Company can now look back on a number of solid achievements. None can doubt that the contributions made by stations such as this to agricultural progress are an essential and increasingly important factor.

Lindane and DDT Incorporated in Smoke Insecticide

WAECO Ltd. announce a change in the composition of their DDT/Gamma BHC Smoke Insecticide. The benzene hexachloride previously used is now replaced by Lindane—Lindane being the pure and completely odourless gamma isomer of BHC—thus making that insecticide available wherever it is needed without consideration for the presence of foods susceptible to BHC tainting. Lindane, WAECO emphasise, cannot taint.

The new DDT/Lindane is available in the same range of pellets and generators as the former product.

International Commission of Agrarian Industries

The ninth congress of the International Commission of Agrarian Industries will be held in Rome from May 23 to 31, 1952, reports our Rome correspondent. Baron Luigi Ricasoli, a well-known wine-grower, has been appointed President of the Organising Committee.

The work of the congress will be divided into about 40 sections. There will be a general opening report, four general informative reports, and about 30 priority reports by scientists and technicians from many parts of the world.

There will also be many reports on various subjects of agricultural, scientific, economic and industrial interest, including the production of sugar, yeast, oils, fats, canned goods, dairy products, food for livestock, tobacco, cellulose, fertilisers, agricultural chemicals, as well as distilling, fermentation, etc.

International congresses of this nature are organised every two years by the International Commission of Agrarian Industries which resides in Paris. The seventh congress was held in Paris in 1948 and the eighth in Brussels in 1950.

Part of the Gezira research farm and laboratories; Blue Nile in the background

The Gezira Scheme in the Anglo-Egyptian Sudan

PART III

H. FERGUSON, B.Sc., N.D.A., N.D.D.

Chief Agronomist, Research Station, Sudan Ministry of Agriculture

In this, the third and concluding of Mr. Ferguson's series of articles, he describes the place of agricultural research in the Gezira scheme. The success of the scheme is in considerable part the measure of the achievements of agricultural research. There cannot be many parts of the world where one can find a parallel to the relationship between practice and research which exists in the Gezira.

AGRICULTURAL research in the Gezira is carried out by the Research Division of the Sudan Ministry of Agriculture, and is thus independent of the Gezira Board, though the latter makes a substantial financial contribution towards it. Before the establishment of the Gezira Research Farm, near Wad Medani, in 1918 agricultural research in the Sudan had been carried out partly at the Shambat Research Farm and partly in the Wellcome Tropical Research Laboratories, both in the vicinity of Khartoum. In 1919 the Shambat farm, like the Gezira Research farm, was put under the Department of Agriculture, while the Wellcome Laboratories continued under their own administration. To begin with, agronomy, botanical and plant breeding work were carried out by the Agricultural Department, partly at Wad Medani and partly at Shambat, and chemical and entomological work continued to be carried out by the Wellcome Laboratories, though some of their staff were stationed at the Gezira Research Farm. As time passed, more and more of the work and staff were transferred to Wad Medani.

In 1931-32 all research work was brought under the direction of a Controller, later Director, of Agricultural Research, both the Shambat and Wad Medani farms coming under his control, and the Wellcome Laboratories staff being seconded to him. M. A. Bailey was appointed controller and, despite changes of name and status, the organisation he set up has continued to be the basis of agricultural research in the Gezira. Bailey concentrated first on the problems of blackarm and leaf curl, and the co-ordinated and concerted efforts which he encouraged undoubtedly hastened the successful solution of these problems. This important work is only part of a volume of first-class agricultural research of which the Sudan is justly proud.

The Gezira Research Farm

In 1935 the Gezira Research Farm was made the headquarters of agricultural research in the Sudan and by 1936 most of the staff and work connected with the Gezira were concentrated there. With this reorganisation the Wellcome Laboratories gave up their agricultural activities completely, but Shambat was retained as a cotton breeding and plant quarantine station because of its isolation from the main cotton areas of the Sudan. At the present time the Chief of the Research Division administers the agricultural research of the whole Sudan from his headquarters at the Gezira Research Farm. Most of the research carried out there deals with Gezira problems only, but, as facilities and staff are larger than elsewhere in the Sudan, a good deal of non-Gezira work is also carried out. Research work is carried out by five main sections, *viz.*, Entomology, Soil Research, Agronomy and Plant Physiology, Botany and Plant Pathology, and Cotton Breeding. These sections, though run as separate units, co-operate and routine work is so organised that the section best equipped to carry out any particular piece of work does so. All sections have well-equipped laboratories, and carry out complementary programmes of field and laboratory research. The senior staff of the Cotton Breeding Section is mainly provided by the Empire Cotton Growing Corporation, and the Sudan owes this body a great deal for its continued co-operation over many years.

The farm area comprises just over one thousand acres of land. One section of this is kept strictly to the standard eight-course rotation, and all other parts of the farm not under long-term experiments are run on rotations wide enough to maintain fertility. The Agronomy and Plant Physiology Section runs most of the field ex

periments and consequently this section is responsible for the management of the farm. The Gezira Research Farm was one of the first research establishments to adopt the experimental technique developed by Fisher and, except for preliminary and exploratory experiments, all experiments since 1926 have been planned to give statistically analysable results.

Organisation and contacts

Research workers are always in close touch with Gezira problems and close and informal contacts are maintained between Gezira board staff and research workers. In addition to individual contacts two organised meetings are held annually at the Gezira Research Farm. At one of these the board staff describe all aspects of the previous season's crops, and at the other current research problems are discussed. The Gezira board is also represented at the meetings of the London Advisory Committee on Agricultural Research in the Sudan, which is constituted to provide the Sudan with the best available advice from overseas. A feature of the co-operation between the board and the research division has been the readiness with which the former has undertaken large-scale experimentation. Whenever research workers have obtained results likely to be of direct practical value the board has undertaken to try them out on areas of several thousand acres and in different parts of the scheme. Because of the layout and organisation of the scheme it is possible to replicate and randomise these trials as in any small scale field experiment. Frequently the adoption of new practices in the Gezira is no more than the extension of these large-scale experiments.

The main events in the short history of research in the Gezira appear to have occurred in logical sequence, starting with proof that cotton would grow. Cotton had been grown successfully before organised research was started in the Gezira. Despite this the basic problems of the environment were recognised right from the beginning and these, together with the need to establish the best practices for a new crop under new conditions, provided adequate work for the research service as soon as it started. As was to be expected, large-scale cotton growing brought with it many new problems, especially those of pests and diseases, and for a time the research division had to concentrate all its resources on these. The solving of these problems established the cotton crop securely and research is again occupied with basic problems, long-term issues, and refinements of past work.

A good lubia crop at the research farm

Problems of environment

In the early days considerable fears were expressed that soil deterioration would follow a period of irrigation. The accumulation of salts in soils that were already salty was the most likely cause of deterioration. Much early work consisted of the study of the properties of Gezira soil, and this in itself showed that salts were not accumulating rapidly either from the lower soil levels nor from the irrigation water, and that the problem was not an urgent one. The soil was too impermeable for underground drainage to be effective even with the addition of gypsum. This established method of dealing with salts was therefore not possible in the Gezira, and, incidentally, it was proved that there was no danger of deterioration from a rising water table. As was to be expected applications of gypsum to flocculate the clay improved permeability and increased cotton yields. Without the permanent removal of sodium salts the effect was not lasting and thus gypsum application was uneconomic. Salt tolerant crops such as sugar beet were tried, but none of the orthodox crops were economic, nor did they reduce the sodium content of the soil by an appreciable amount. However, it was shown that one crop of salt-bush (*Atriplex muelleri*) could remove as much sodium as irrigation water added in 12 to 16 years. Many crops would be required to effect an appreciable reduction in the original soil salts, and, moreover, as salt-bush made heavy demands on soil nitrogen, it could not be fitted in as a crop in the rotation.

Nitrogen

The low nitrogen content of Gezira soils was established at an early date and work on the nitrogen status has been in progress ever since. It has been established that nitrate is the main source of available nitrogen, and it appears that factors favouring nitrate formation are of more importance in crop production than the total nitrogen content of the soil. This has been demonstrated in some rotation experiments. Table 1 gives a comparison of three-course rotations. It will be seen that dura-dura-cotton has relatively high soil nitrogen, relatively low nitrate and poor yields, while fallow-fallow-cotton has low organic nitrogen, high nitrate and good yields.

It has been shown that there is a zone of high nitrates at depths of 3 to 6 ft. downwards. With the gradual penetration of irrigation water over a period of years this accumulation is likely to become increasingly available to crops.

As will be seen from Table 1 leguminous crops are of distinct value in improving the nitrogen status of the soil. Experiments in the disposal of the lubia crop have shown that it is most effective when used as a green manure and least effective if utilised away from the land. It was established early that nitrogenous fertilisers gave significant increases in yield. Farmyard and other organic manures also give significant increases, but in practice the Gezira could only produce enough of these to manure a very small area. So far there has been no real evidence of a permanent build-up of fertility from either organic or inorganic manures.

The climatic environment does not lend itself to experimental study as easily as does the soil, but certain aspects of it are dealt with later.

TABLE I—THREE-COURSE ROTATIONS EXPERIMENT

Rotation	*Organic nitrogen p.p.m.*	*Nitrate nitrogen p.p.m.*	*Yield of seed cotton kantar per feddan*
Lubia-fallow-cotton	320	10.9	4.57
Fallow-fallow-cotton	307	9.0	4.24
Dura-lubia-cotton	329	8.5	4.06
Dura-fallow-cotton	308	8.3	4.05
Dura-dura-cotton	312	5.8	3.0

(Nitrates and yield are 16 years' averages. Nitrogens have only been studied recently and the figures are included by courtesy of T. A. Jones, who is at present engaged on this work.)

Husbandry methods

It was mainly in connection with the problems of crop husbandry that Fisher's methods of experimentation were introduced, and a series of long- and short-term experiments were designed by E. M. Crowther, M. A. Bailey, F. G. Gregory, and F. Crowther, which have not only contributed a vast amount of useful information to the Gezira but have achieved fame outside the Sudan. The results of these have been published by F. Crowther and others.

A series of factorial experiments established the best sowing date, spacing, thinning rate and water rate for cotton, and the interaction of these factors with each other and with manuring. As these experiments were repeated in different seasons and in different parts of the Gezira the results were widely applicable and are now embodied in Gezira standard practice. A large number of manurial experiments have been carried out and have provided valuable information on rates, methods, and time application of different types of nitrogenous manure. Fertilisers were introduced into Gezira practice through the medium of large-scale experiments.

Irrigation investigations

A series of plots at the research farm is equipped for the accurate measurement of irrigation water, and the effect of different levels of watering on the cotton crop has been established on these. The original purpose of these experiments was to find out the optimum amount of water for maximum cotton yield, but it was also shown that considerable economy of stored water could be effected at the expense of only small reductions in yield. With recent extensions of irrigation in the Gezira and elsewhere in the Sudan, this aspect of the problem has come to the front. It was found possible to economise in three ways, by reducing the amount of water per watering, by lengthening the intervals between waterings, and by cutting out the last one or two waterings. Large-scale trials have shown that the last method is the only practicable one, the water economy being insured as it is effected before and not after the water is delivered to the tenant. This method of economy will be put into effect throughout the Gezira when the present extension is completed.

Rotations

A series of rotation experiments have been established at the research farm. By sticking to relatively short cycles and to the three main Gezira crops it was possible to avoid the extreme complexity often associated with such experiments and to design statistically sound layouts. The first of these experiments was started in 1918, and most have run long enough to give reliable direct responses to the rotations, though there is still no evidence of any permanent amelioration or deterioration associated with any particular rotation. The results of the Three-Course Rotation Experiment given in Table 1 are in accordance with those obtained in other experiments. The most ambitious rotation experiment being carried out is the Combined Rotations Experiment. In this, 10 rotations of varying length are compared in randomised blocks, each containing all phases of all rotations every season. This experiment has shown that better cotton yields are obtained when the number of fallows between each cotton crop is largest, and that lubia is of more value than fallow in the rotation provided that one or more fallows occur between the lubia and cotton crops. These experiments have confirmed the superiority of the present wide rotation used in the scheme, and the results are available whenever any change of rotation or development of a new area is contemplated.

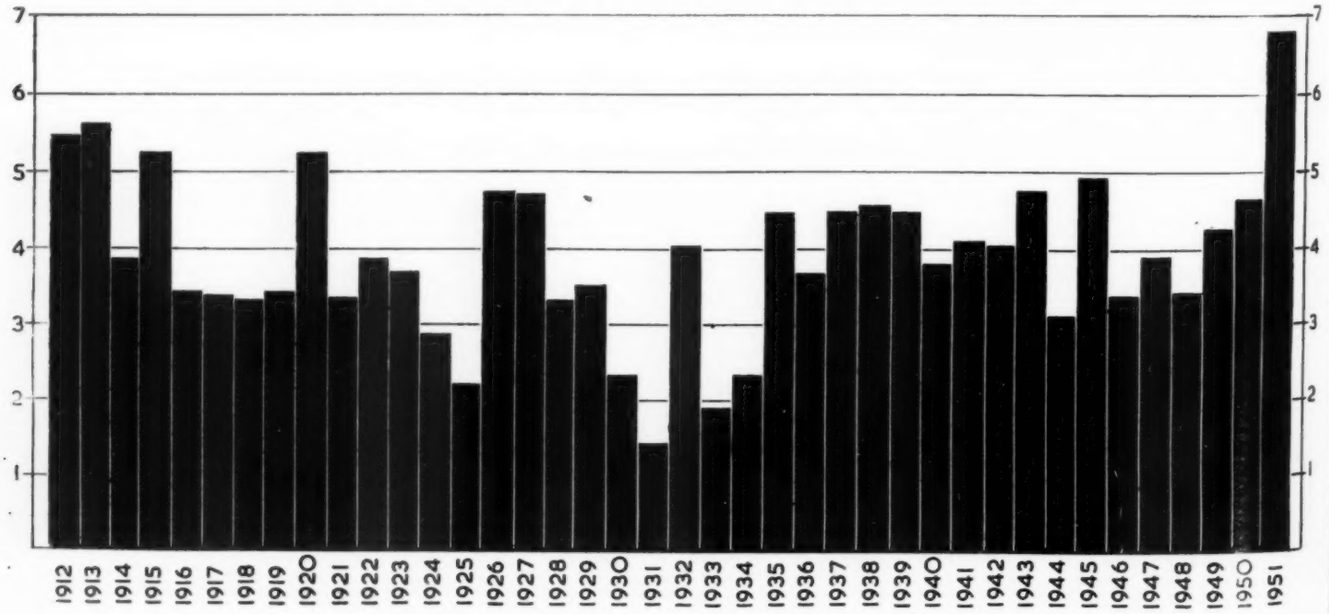
Pest and disease problems

A good deal has already been said about the control of blackarm and leafcurl. The relationship of the blackarm organism (*Xanthomonas malvacearum*) to its host plant and environment was studied by careful observation and experimentation. The salient results of these investigations and their value in suggesting control measures has been indicated earlier in this series.

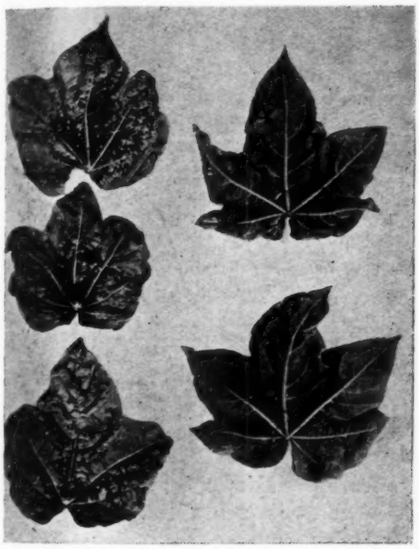
At first, leafcurl was thought to be a symptom of mineral deficiency and investigations into this possibility were carried out. An apparent association between insect-infested crops and leafcurl was noted by R. E. Massey, and entomological study in due course confirmed that the disease was a virus and showed that whiteflies (*Bemisia gossypiperda*) were the vectors. The relationship between ratoon cotton plants and infected alternate hosts and the infection of the cotton crop was then established, and became the basis of control measures.

Research on insect pests consisted mainly in establishing their life cycles and en-

AVERAGE YIELDS OF GEZIRA COTTON (IN KANTARS PER FEDDAN), 1912-1951



vironmental and host relationships in the Gezira. Particularly in the case of pink bollworm (*Platyedra gossypiella*) methods of control have been based on these. Development of DDT, Gammexane and, more recently, systemic insecticides have offered new possibilities of control which both the research division and the Gezira board have been prompt to follow up. Recent entomological research has concentrated on jassids (*Empoasca libyca*), and the large-scale spraying carried out in the Gezira is accompanied by observations and experimentations. It was shown that rain reduced the jassid population on cotton and alternate host plants, large numbers of insects being killed by mud splash. Thus seasons of high rainfall tend to have light jassid attack.



Cotton leaves affected by blackarm. Those on the right are from a more resistant strain than those on the left

Weed control

Apart from the work on fallow weeds described below most original research on weed control in the Sudan has been carried out on nut grass (*Cyperus rotundus*). Andrews showed that the tubers of this plant played an important part in maintaining growth through the dry season and in propagating the weed, and that they were kept alive in dry weather by water obtained by the roots from the deep layers of the soil. They were found to occur within the top 12 in. of soil, and ploughing to 13 in. cut off all tubers from their dry season water supply. This method of control has proved to be of value on a field scale and is now carried out in the worst infested areas of the scheme. Tubers depend on nutrient from the leaves, and constant hoeing of the tops ultimately results in exhaustion and death of the tubers.

Plant observations being made at the Gezira research farm

The development of hormone weed-killers has opened up new possibilities. They have been found to be effective against annual weeds in fallows, canal weeds, and the dura parasite *Striga hermonthica*. Trials with these weed-killers are still being carried out and it is still too early to assert their value on a field scale.

Seasonal fluctuations in yield

In a scheme in which so many factors affecting crop growth are under control there has been a remarkable variation in the seasonal yields of the cotton crop. This is illustrated in the accompanying diagram, which gives the average yield of cotton for the total cotton area for each season since cotton was first grown in 1911. In considering these yields it should be noted that until the 1925-26 season they came from the small areas of better land irrigated by pump irrigation, and up till about 1934-35 blackarm and leafcurl had not been effectively controlled. Thus the very low yields of the 1928 to 1934 period are in large measure due to these diseases. Yields from 1934-35 onwards apparently were not seriously affected by pests or diseases, though jassids may have played a more important part than was previously realised.

Several approaches were made to this problem. An ' observation ' plot had been established in 1925 in which detailed observations of plant characters and certain environmental conditions were recorded in addition to yields. Three similar observation plots were started in different parts of the Gezira in 1939 and a fourth added in 1945. The data from these plots provided a wealth of information which enabled an analysis of the factors affecting each season's yield to be made. A number of correlations were established, many of them fairly obvious, *e.g.* low yield correlated with high leaf shed. One of the most interesting was a correlation between yield and the percentage of nitrogen in leaves at seven days old. Although these plots have contributed a great deal to our knowledge of the behaviour of the cotton plant they did not indicate the fundamental factors causing the fluctuations.

Two other experiments deserve mention. In one of these cotton plants were grown in Gezira soil in which soil moistures and temperatures were standardised, and in the other, cotton was grown in soil transported to the Gezira from the Gash. This soil is a silt of much lower salt content and greater permeability than that of the Gezira. In both these experiments seasonal fluctuations were recorded, thus proving that they were not associated with any unique property of Gezira soil.

Weather and yield

A purely statistical approach to the problem was made by F. Crowther, who looked for correlations between yield and various meteorological factors. He found two significant correlations; first, that a high rainfall in the season before the cotton crop was correlated with low yields, and second, that a high rainfall during the six weeks immediately preceding cotton sowing was correlated with high yields. One interesting outcome of this discovery was that a regression equation was worked out which gave an estimate of the cotton yield about the time the crop was sown. This has been remarkably accurate on several occasions, but it is unwise to lay too much stress on these correlations and estimates, as they are based only on the short series of years following the control of blackarm and leaf curl.

A high rainfall in the season before sowing cotton causes a heavy growth of weeds on the pre-cotton fallow, and it was shown by experiment that hoeing these weeds resulted in increases of up to one kantar per feddan in cotton yields. It was shown that both moistures and nitrates were higher in hoed than unhoed fallows, and further experiments have shown that nitrates are the more important in the Gezira. The response to fallow hoeing is greatest after seasons of heavy rains and thus heavy weed growth, and this is undoubtedly the main mechanism of the previous rains—yield correlation.

The rain during the six weeks before sowing probably functions through several factors. The problem is still under investigation, but it is probable that the effect of rain on jassid population is one important factor.

Thus, hoeing of fallows and spraying of jassids are two practical methods of counteracting adverse seasonal factors.

Both rainfall factors were extremely favourable for the 1950-51 season, but, apart from this, the extremely high record yield was certainly in part due to the application of research. This is brought out by comparison with the poor yield of the 1929-30 season, when the rainfall factors were even more favourable than in 1950-51, but when blackarm, leaf curl and jassids were not under control (this comparison assumes that the rainfall factors had the same effect on inherent growth factors in both seasons, and should not be accepted as an exact measure of disease effects).

New cotton varieties

It has been stressed elsewhere that any relaxation in the control measures against blackarm and leafcurl might mean disaster to the cotton crop. This is a risky situation and the considerable success achieved in breeding disease-resistant cotton varieties is of the greatest importance to the Gezira.

R. L. Knight and T. W. Clouston, by using a standard method of infection and a fixed scale of damage, were able to show different degrees of resistance to blackarm disease in different varieties and species of cotton. The degree of resistance was associated with the presence of genes designated B1, B2 and B3, the two first being found in some American cottons and the third in *Gossypium punctatum*. The introduction of these genes into Egyptian cottons (*G. barbadense*) necessitated crossing with the above types of inferior lint quality, and Knight applied the back-crossing technique to bring the quality of his progenies back to that of the original Sakel and X1730A. The factors for resistance were retained by discarding all seedlings showing the higher degrees of damage after standard infection. Resistant Shakel and X1730A cottons of the same quality as the original strains are now under large-scale trial in the Gezira.

Jassid resistance in cotton depends on the density and length of hair on the leaf. Egyptian cottons are smooth and Knight has introduced these characters into Sakel types by using a back-cross technique similar to that used for blackarm. Though jassids have never threatened to eliminate the crop, their control is expensive, and the introduction of resistant varieties would be of considerable financial benefit.

Resistance to leafcurl is being increased by mass selection, followed by intensive intercrossing within the present strains of Sakel and X1730A.

Research on other crops

A certain amount of research has been done on the husbandry of dura and lubia, both for their own sakes and in relation to cotton. The relationship to each other and to cotton has been established in various rotations and experiments with nitrogenous fertilisers, spacing, watering, etc., have been carried out on dura. Disease and pest problems have received some attention.

A surprisingly large number of crop plants have been introduced at the Gezira Research Farm from time to time and kept under observation for varying periods. A limited number of these have grown successfully, but, as far as can be judged, they would all be very much less profitable than cotton. If mixed farming develops in the Gezira there will be a place for new fodder crops and possibly new subsidiary cash crops to increase the welfare and security of the tenantry. With this in view, exploratory trials with a number of cash and fodder crops are being conducted at the present time.

This completes a very brief review of the research work which has made a direct contribution to the Gezira scheme. Much of this work has been published, but space does not permit of the listing of all relevant literature. Interested readers are referred to Tothill's *Agriculture in the Sudan*, which contains an excellent review of published work up to 1944, and to Knight and Boyn's *Agricultural Science in the Sudan*, in which all publications before 1949 are listed and reviewed. Reference to the published work of all the research workers mentioned above will be found in the latter volume.

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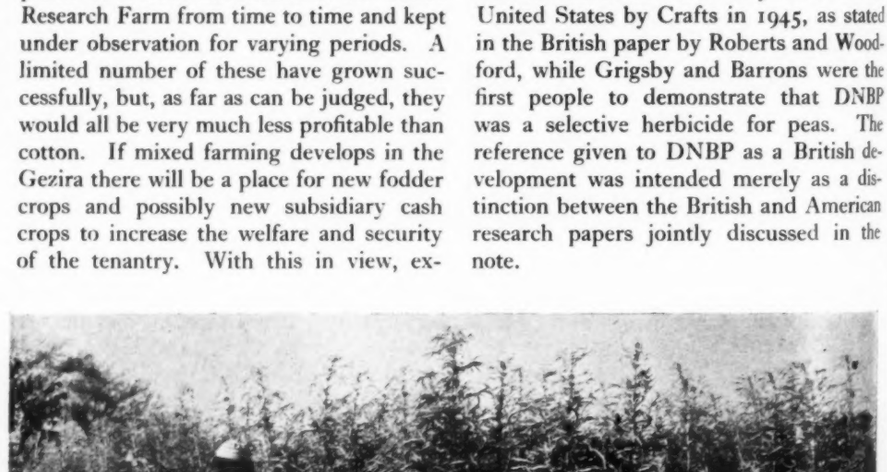
Photos: Pp. 99-102, Gezira Information Office; p. 98, Gezira research farm.

DNBP

In the note on two new weedkillers, published on p. 76 of the current volume, the impression was inadvertently given that DNBP is a British discovery. In fact, it was shown to be selectively toxic in the United States by Crafts in 1945, as stated in the British paper by Roberts and Woodford, while Grigsby and Barrons were the first people to demonstrate that DNBP was a selective herbicide for peas. The reference given to DNBP as a British development was intended merely as a distinction between the British and American research papers jointly discussed in the note.



Trial plot of Deccan hemp (Kenaf)

Shell D-D for Eelworm Control

J. C. HIGLEY
Shell Chemicals Ltd.

The following account describes some of the latest developments in the British Isles with the use of Shell D-D, a petrol derivative used as a nematocide and soil insecticide.

Injecting D-D soil fumigant in a greenhouse using guide strings. Injections are carried out up one guide string and at intermediate positions on the other

SHELL D-D is a volatile liquid mixture of chlorinated hydrocarbons (dichloropropane-dichloropropylene) derived from petroleum, and was first developed, agriculturally, in the U.S.A. for controlling root-knot eelworm (*Heterodera marioni*) on a wide variety of crops, including pineapples, potatoes, carrots, tomatoes, and tobacco. It is used very extensively in the U.S., and also against the same pest over large areas in Rhodesia, South Africa, French North Africa and the West Indies. In some instances, however, it is used rather as a soil insecticide than as a nematocide.

Methods of application

The basic method of applying Shell D-D is to inject it into the soil, under suitable conditions, and allow the vapour to spread through the soil particles and so make contact with the pest.

For use in glasshouses and small areas a hand-operated injector 'gun' was developed at an early stage. This is used by inserting it into the soil at intervals of 15 in. and injecting a predetermined amount by means of a plunger.

Injections against root-knot eelworm on tomatoes are made at the rate of 300-400 lb. per acre, the amount varying according to the degree of infestation and the type of soil. For large areas, a hand-injector is inadequate, so various types of machines have been developed to treat any required acreage.

From the outset it appeared simplest to leave a series of traces of D-D in the soil about 6 in. deep and at intervals of about 9-12 in., so that the D-D, after volatilising, would eventually completely cover the ground. The latest machines still retain this principle.

The earlier machines, however, relied upon a motor-driven pump for transferring the material from a 40-gal. supply tank to six cultivator tines, each fitted with a copper tube leading down behind the foot. These machines proved effective and are still in use today, but their main disadvantage lies in the fact that they are heavy, unwieldy, somewhat complicated and therefore expensive.

The material is applied by towing the machine over the field at a definite speed, while the D-D is forced at a predetermined pressure (usually between 20 and 40 lb./sq. in.) through small metering discs or jets. The relations between the variable factors, *i.e.* jet size, speed and pressure, are previously plotted on a chart.

The latest types of machines still retain the principle of various sized jets and must be driven at definite speeds according to the dosage required, but the D-D is fed by gravity instead of by a mechanical pump. These machines are thus simpler, and therefore cheaper to construct.

When the supply tank is full there is a greater head of liquid supplying the injector tines than when it is nearly empty, and so the dosage will vary. To combat this a simple constant head tank has been evolved that delivers an even supply to the tines whatever the contents of the supply tank. Also the supply tanks are specially shaped so that they can be emptied completely, whatever the gradient of the field being injected. The machines may either be mounted on a tractor or towed behind as a complete unit and a modified model can be attached to a plough.

Root-knot eelworm

In Britain root-knot eelworm does not normally live outdoors owing to the low temperatures obtaining in winter, but early trials were carried out in the autumn and winter of 1945-46 with D-D, to control the eelworms which attack tomatoes grown under glass, and the results were so promising that in the following year extensive trials were carried out in many centres all over the country. These latter trials were carried out under normal commercial conditions.

Potato eelworm

Unlike the root-knot eelworm, the potato eelworm (*H. rostochiensis*) forms tough resistant cysts during a stage in its life cycle. Such cyst-forming species are more difficult to control, and in 1947 trials were started in Ayrshire using D-D in an effort to control *H. rostochiensis* on early potatoes; these trials continued for three years.

Injections were made at 200 lb., 400 lb., and 800 lb. per acre on three farms soon after heavily infested crops had been lifted, and treatments were suitably replicated with control plots so that statistical results could later be obtained. At lifting time a number of plants were taken at random from each plot to make up a definite fraction of an acre, so that calculations could eventually be made on the basis of tons per acre.

Treatments at the rate of 800 lb. per acre were not economic, and it was found that the following crop tended to be poor solely as a result of over dosage.

At the lower concentrations there was an increase in yield and a definite decrease in eelworm attack.

It is important to note that these trials have shown that the effects of a single treatment are still seen three years later, although the percentage increase in yield falls progressively in the second and third years.

Typical examples of crop increase resulting from D-D application can be seen in the following table. In each of the four examples, the trial extended over three years after one treatment:

Cost of Shell D-D	*Value of additional crop*
Treatment at 400 lb. per acre:	
£	£ s.
1. 30	54 14
2. 30	44 15
3. 30	100 12
4. 90	145 6
Treatment at 200 lb. an acre:	
1. 15	45 1
2. 15	34 8
3. 15	34 17
4. 45	77 5

It is, of course, realised that the value of additional crops will vary each year according to the price obtained for early potatoes, but the above figures give an indication of what may be expected.

Shell D-D will not eradicate an infestation of cyst-forming eelworms with one application—although the number of cysts is very considerably reduced over a three-year period—because, to treat one acre of soil to a depth of only eight inches, it is necessary to fumigate completely about 1,000 tons of soil. Further, there are thousands of acres in the country where infestation is so heavy that there are about 10 eelworm cysts being produced per year for every inch of potato root. Thus, treatment cannot necessarily be regarded as a short-term operation, but rather as a long-term policy.

Finally, no taint of any kind has been found on early potatoes so treated, provided that treatment is applied at the correct time, namely, immediately after a crop has been removed.

Bulbs

Some years ago it was observed that daffodils in the Isles of Scilly were suffering from a malady which had the effect of withering the bulb-roots to such an extent that the flower crop was being seriously depleted. The Islands' inhabitants rely upon the early flower trade for their livelihood, and this 'sickness' gave cause for considerable alarm.

At first it was thought that this 'root rot' was being caused by direct fungal attack, but it has now been established that an eelworm—*Pratylenchus pratensis*—causes initial injury, thereby allowing other organisms (probably including other eelworms) to complete the destruction. *P. pratensis* seems now to have become known as the bulb root-rot eelworm.

In view of the foregoing, Shell D-D was tested on a small scale on the Islands, and it was found that the treated bulbs successfully resisted eelworm attacks to such an extent that first-class flower crops could once more be confidently expected, together with excellent growth of both foliage and bulbs.

One application appears to have this effect for up to three years afterwards, which fits in very well with the Scillonians' usual method of growing bulbs, as they allow a field to produce flowers for about three years before replacement with fresh stock.

Apart from its nematocidal and insecticidal action, it is claimed that Shell D-D appears to create a condition of 'soil amendment' in which crops of all kinds grow with greater vigour and display luxuriant dark green foliage. This effect has been noticed when eelworm and other soil pests have been absent.

The effect of eelworm on a tomato root

Photos: Shell Petroleum Co. Ltd.

African Soils

The African Soils Conference held at Goma in the Belgian Congo in November 1948 recommended the establishment in Paris of an Inter-African Information Bureau for Soil Conservation and Land Utilisation.

The object of this was to be the collection of technical information on soil conservation, and the maintenance of contact with local regional committees for soil conservation which the conference recommended should be set up in various African areas.

As part of its activities it was decided the Bureau should publish periodically a bulletin in English and French, containing notes, reviews and abstracts on current work.

The first issue of this journal has recently appeared and we have been furnished with a copy. It contains articles by a number of authorities, including one by Dr. H. Greene, Advisor on Tropical Soils, Rothamsted Experimental Station, on Soil Conservation in British Colonial Africa, one by M. Guilloteau, Director of the Bureau, on Inter-African Organisation for Soil Conservation, and another by F. Jurion, Director-General of I.N.E.A.C., on Soil Conservation in the Belgian Congo, together with a large number of notes on various other subjects connected with soil conservation.

The publication is well produced and is illustrated. Judging from the promise of the first number, it should fulfil a very useful prupose.

We wish the Bureau and the publication every success.

FAO Rice Breeders' Working Party

The advantages of co-operation in cereal breeding are well exemplified by the FAO Rice Breeders' Working Party which was established by the International Rice Commission. Fourteen countries in Asia and the Far East participate in a rice-breeding programme which after two years is showing beneficial results.

The second meeting of the Working Party, convened by FAO, was held in Bogor, Indonesia, in April 1951, and a comprehensive breeding programme was formulated. Consideration was given to the requirements of a hybridisation scheme under which over 80,000 cross-pollinations between varieties of the *Japonica* and *Indica* groups of rice have already been made, and for the extension of such co-operation to other investigations. Technical problems concerned with the production of improved varieties of rice were discussed. In October 1951 Dr. K. Ramiah, former Director of the Central Rice Research Institute, Cuttack, India, was appointed, in response to a recommendation of the Rice Breeders' Working Party, to assist in co-ordinating the rice-breeding work in the various participating countries. A training centre for rice breeders, which FAO was also requested to establish, has been organised for September-December 1952. The centre will provide the necessary staff and facilities for advanced training in the principles of rice breeding.

The third meeting of the Working Party will be held in May this year.

The boon of electricity. Work on the farm is speeded up with the help of these electrically operated machines, a grain cleaner (*left*) and tool grinder (*right*)

Farm Electrification in the Prairie West

J. GRINDROD, B.A. (Com.)

More and more attention is being paid to the use of electricity on farms as a means of economising labour, and the manner in which electric current can be applied to doing the everyday jobs of the farm, as well as the farm home, increase almost daily. This article describes the manner in which farm electrification is being extended in the prairie provinces of Western Canada.

LOW-COST electrical energy is fundamental to the development of Canada industrially, and it is, perhaps, worth while considering to what extent agriculture in the three prairie provinces has been able to take advantage of this source of light and power, and what are the possibilities of the future.

Although the provinces, Manitoba, Saskatchewan and Alberta, together contribute about half the total of farm products for the whole of Canada, they have, because of the sparsity of their populations, been a much greater problem, from the point of view of electricity supply, than other provinces such as Ontario. Indeed, until quite recently, it was widely considered almost impracticable to bring electricity to many of the farms. Since the war, however, determined efforts have been made to reach the scattered holdings and rural communities in the southern regions of all three provinces. Today, much headway is being made. While in 1941 less than 1% of the farms were enjoying power line electricity, in 1950 over 30,000 farms were being served, representing 11% of the 275,000-odd farms in the Prairie West, and it is expected that over 10,000 additional farms will be connected up annually.

In order to make this commercially possible it was found necessary to reduce the costs of constructing a satisfactory rural transmission system and also to ensure that sufficient use would be made of the electricity to warrant the connection.

Transmission costs were reduced by as much as 50% by bringing to bear new ideas and using new metals and materials. Special types of conductor were evolved by combining aluminium or copper with steel, which reduced weight without loss of strength. This made it possible to place the poles for farm transmission lines 400 ft. apart, saving poles, hardware and labour. Special types of transformers, hardware and other equipment were developed for rural service and construction methods were modified. Wires were strung vertically, eliminating crossarms.

The farmer's attitude

At first the prairie farmer was inclined to look upon electricity supply as a means of reducing the drudgery and increasing the comforts and amenities of his home. Today, with rising costs of production, and, in particular, labour costs, he is conscious of the value of electricity in cutting down farm costs and increasing operating efficiency. Pumping water and heating it in the prairie winter, hay drying and hoisting, grinding, cleaning and elevating grain, power for the workshop and dairy, ventilation, spraying, refrigeration are but a few of the 300 and more uses for electricity on the farms listed by supply authorities. The conveniences that electricity brings to the home will, perhaps, encourage those who have been used to moving into town for the winter months to remain on the farm, while those town-dwelling farmers, who, like the city business man in reverse, have hitherto travelled daily to and from the farm, might think it more worth while to live on the premises. It is also hoped that it will help to check the drift to the towns of the younger members of the farming communities.

Development in the provinces

Manitoba.—Although the prairie provinces have a number of electricity problems common to each, they are, nevertheless, served by different supply authorities, and, having also special problems of their own, have adopted their own methods of dealing with them. They have also reached different stages in the carrying out of their respective tasks.

Manitoba, the most easterly of the three provinces, has the advantage of being a smaller and more compact area than the

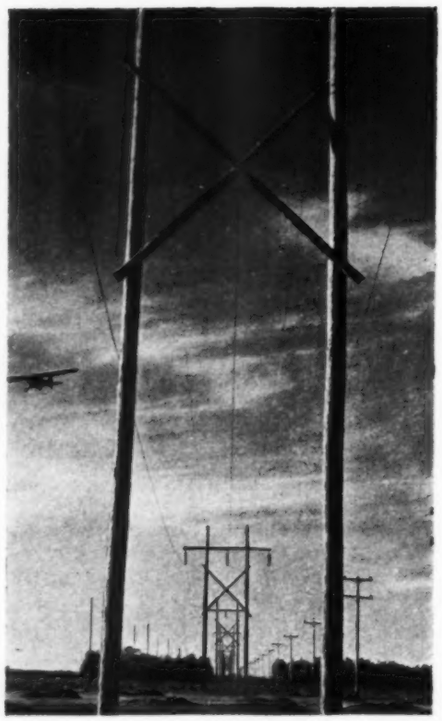
other two. Having already a far-reaching network of transmission lines to numerous cities, towns and villages, the Manitoba Power Commission was well supplied with a framework upon which to build its farm electrification programme. A Government Commission in 1942 reported that a service could be brought to at least 90% of the farms in the province, and, in spite of being faced with a density of population as low as 1.3 farms per mile and resulting high power costs, a start was made.

Seven experimental areas were mapped out and 674 farms, requiring 550 miles of line, were supplied with electricity. Based on these tests, plans were put in hand to bring 5,000 farms every year within the scheme, but, until 1948, it was found necessary to reduce this target because of shortages of material. This goal has been met each year since, and, when the 1951 programme has been completed, 27,000 of the 58,000 farms will have been served.

The Manitoba farmer is in the fortunate position of having the electricity brought to his yard pole without cost to him; his only expense is for wiring his buildings and buying appliances. This service is given on the basis of a 'self-help' programme, assurance being given by the farmer that adequate use will be made of it. A local committee undertakes a canvass of each area to be developed electrically, in which at least 65% of all farms must contract for service before the construction of the lines begins. Each farmer agrees to buy a certain minimum of appliances, thereby assuring the Commission of a reasonable return and, himself, the full benefit of electricity. It has been found, in practice, that the farmer usually spends about dollar for dollar with the Commission in buying equipment. Farmers read their own meters and mail readings to the Commission's central Billing Department. On this basis consumers find the use of electricity profitable and have testified that lights in the henhouse alone have increased production enough to pay for the entire energy bill. One farmer has told the Commission that his electricity does the work of three hired men on his farm, presumably a mixed one, for an average cost of $7.49 per month.

In most cases farmers are able to run motors up to 3 or 5 h.p. on their standard service, but when operations call for a larger block of power this can usually be obtained and even three-phase service for a very large load is often available to farmers adjacent to a trunk line.

Primary voltage for farm areas on the Manitoba Power Commission system is either 4,600 volts or 6,900 volts to ground. Lines can radiate from a sub-station for a distance of approximately 18 miles, when operating at 4,600 volts, and 30 miles at 6,900 volts.



150,000-volt transmission lines leaving Parkdale terminal station for Portage la Prairie

The average demand per farm is approximately 1 kVA, and the average monthly kilowatt-hour consumption for farm service is 150 kWh per month.

The Manitoba Power Commission sells electricity to rural Manitoba only and not to the city of Winnipeg. It does not generate its own current but buys from the Winnipeg Electric Company, who own plants on the Winnipeg River. It makes no monthly service charge. The cost of the first 50 kWh is 8 cents, for the next 50 kWh 2 cents, and over 100 kWh 1 cent. Prompt payment discount is 10%, and the minimum bill is $3.60.

The Commission receives government assistance on its farm electrification programme to the extent of a bonus of 3% per annum on its capital investment in transmission lines.

Saskatchewan.—Although in Saskatchewan a Provincial Power Commission was set up by local Act passed in January 1929, not much farm electrification took place until 1949. In that year a Provincial Crown Corporation—the Saskatchewan Power Corporation—was formed, which took over the assets and liabilities of the Commission, the latter remaining as a regulatory body giving special attention to the remaining privately owned and municipal plants.

Up to then only 1,466 of the 126,000 farms in the province enjoyed grid electricity, but in recent years rural areas have received more attention. In 1949 1,142 farms were added to those served, and in 1950 the total number of farms supplied was in the region of 4,500, the annual target now being 2,000 farms a year. It is estimated that electrical equipment to a total of 200,000 h.p. is already being used.

Sources of power are mainly steam generating plants, but there is one natural gas plant and also 29 diesel generating plants.

In contrast to Manitoba, the farmer in Saskatchewan has to pay roughly one-third of the cost of constructing the power line along the road and the whole cost of bringing the line to the farm, and this is usually about $500 or more. Monthly service charge is $2.00. The charge for the first 30 kWh is 8 cents, for the next 20 kWh 6 cents, and over 50 kWh 3 cents. The minimum bill is $5.00.

Alberta.—Alberta is served differently again. Public ownership is confined to a few urban municipalities, while three privately owned utilities are developing the electrification of the rural area, each operating in its own section of the province.

In 1942 only about 500 of the 90,000 or so farms in Alberta were connected to the main line electricity. As a result of experiments in farm electrification carried out in 1943-44 plans for extensive developments were drawn up, and in 1949 2,700 farms were added to the service, bringing the total to nearly 8,000 farms, the annual target from then onwards being 3-4,000 farms a year altogether. About 50,000 farms lie within 15 miles of the present transmission lines and all these are ultimately expected to be supplied.

Costs of rural electrification in Alberta are borne by the utilities in conjunction with the farmers, who organise themselves into co-operative electrification associations, of which in 1950 there were 102, with an average membership of 66 in each association. The farmers do not pay towards the costs of the transmission line, but, through the association, pay the actual cost of bringing the supply from the transmission line to the farms. This includes the step-down transformer, usually from 22 kV to 7.2 kV, or 6.9 kV in the case of the Calgary Power Company. The amount of line required per farmer is about one mile, and the cost is approximately $1,000. It varies, depending on construction conditions, which are influenced by terrain and weather.

The Provincial Government is prepared to back a loan to a co-operative association up to 50% of the cost of the project.

The loan is obtainable at an interest rate of 3½%, either from a bank or through the provincially owned Treasury Branch.

The utilities say that Alberta farmers are very proud of their own co-operative efforts in providing farm electrification for themselves, and, on the whole, prefer this to the service being supplied by the government.

Thus, whereas in Saskatchewan, although the farmer contributes part of the cost from transmission line to farm, the ownership still remains with the supply corporation; in Alberta these lines are owned outright by the co-operatives.

Of the three utilities operating in Alberta, the Calgary Power Company is by far the largest and serves a wide area. Canadian Utilities Limited, also with its headquarters at Calgary, is, however, rapidly extending its rural electrification schemes, while Northland Utilities is a fairly recent company serving the more northerly part of the province, as yet in a small way.

The rate of charge for electricity to the farms by Calgary Power is $3.20 gross, $2.90 net for monthly service charge, which includes 20 kWh. The remainder of the electricity is at 2 cents. The $2.90 minimum makes provision for depreciation contingency and normal operation cost. Usually all maintenance work, reading of meters and replacement of fuses on the line is done by the power company.

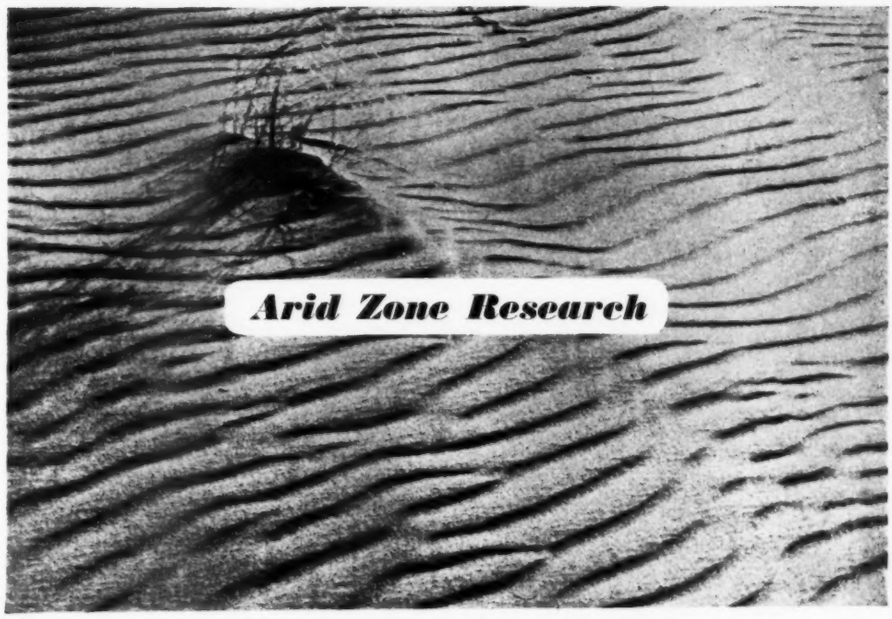
In 1949 the average amount of electricity used by Alberta farmers was in the region of 160 kWh, though a number of the larger farms, of course, used much more than this. The flat monthly rate charged by Canadian Utilities is rather more than that charged by Calgary Power, but the additional 2 cents charge is the same. In either case, if the monthly service charge is more than sufficient for maintenance and depreciation the balance is refunded to the co-operatives.

Conclusion

From the foregoing it follows that, of the three Prairie Provinces, the farmers in Manitoba obtain their electricity with the least amount of outlay, this being in the region of $1,000 per farm, spent wholly on equipment. In Saskatchewan the outlay is around $1,500, while in Alberta it averages about $2,000 per farm. The two latter figures include equipment and all are based on early 1950 prices.

Power failures do occur but are reduced to a minimum and are not regarded as an obstacle to the rapid development that is taking place.

Photos: National Film Board of Canada.



Arid Zone Research

Part of the vast North African desert; photo taken in Egypt

IN 1950 the United Nations Educational, Scientific and Cultural Organisation established an Interim International Arid Zone Research Council to survey the scientific problems presented by the arid regions of the world and to consider what help might be given towards their solution. This Council met in Paris during November 1950 and put forward a programme of activities in this field. It also recommended that UNESCO should set up a standing Advisory Committee on Arid Zone Research to guide the more detailed carrying out of the programme, the main outlines of which the Council had laid down. The Committee, originally of seven members and now to be enlarged to nine, was appointed and held its first meeting in Algiers in April and its second in Paris in September 1951. Its meetings are also attended by representatives of the United Nations Organisation and its relevant specialised agencies, such as the Food and Agriculture Organisation, and by observers from a number of international scientific bodies.

The programme covers: (1) the collection, discussion and dissemination of information already existing and (2) assistance in specific research projects and the encouragement of co-operation between research centres. It seemed reasonable at the present stage that priority should be given to the first of these activities, since better decisions as to research projects can be made when the field of existing knowledge has been adequately reviewed.

The two principal means by which it is proposed to collect and discuss existing knowledge are reports and symposia. Each year a research field will be chosen and reports from authorities in that field will be obtained and published. In the following year a symposium on the same subject will be organised. It is proposed that each symposium should be held in a country having an arid zone and should be accompanied by an excursion.

In the encouragement of actual research projects the Committee's immediate interest has been in problems of hydrology, since this field has been given priority during 1951. It has advised UNESCO to give support to two specific investigations. The first is a study by the Research Centre at Beni-Abbes of underwater flow in the Wadi Saoura, in which this centre is situated and which provides exceptional advantages for studying this problem. The second is a study, assisted by models, of the mechanics of underground water flow in calcareous mountains, to be undertaken by Professor L. Picard, of the Geological Institute, Jerusalem. The Committee invites suggestions about other research projects which might suitably receive UNESCO support. In evaluating suggested projects the Committee, in addition to a consideration of their general merits, is also guided by the following criteria:

(1) The project should be of importance to several UNESCO member states having arid and semi-arid areas; (2) it should come within the scope of the UNESCO arid zone programme at the time the project is proposed; (3) it should be of a type that can reasonably be expected to achieve definite results within a specified period; (4) if already under way, it would be completed or its value would be increased

An oasis surrounded by the sand dunes of Morocco

through financial aid from UNESCO; (5) the results of the research project will be freely available to the public; (6) financial assistance will not be granted to defray the salaries of the permanent staff or the purchase of permanent equipment, buildings or land.

(*Abbreviated from 'Nature,'* **169,** *No.* 4288, 1952.)

Photos: P. 107, *Egyptian Education Bureau; p.* 108, *French Embassy.*

Organo-Mercurial Replaces Sulphur

A new organo-mercurial (called P.P. Mercurial Fungicide) is announced by Plant Protection Ltd. The current sulphur shortage will mean a decrease in supplies of lime sulphur for fruit this year and the new fungicide, of which ample supplies are assured, will be available as a partial substitute. Results are claimed to be better than those of dispersible sulphur, but not quite equal to the normal sulphur programme. Varieties susceptible to damage from mercurials should not be treated with the new product.

Mr. C. T. Ward and Mr. C. M. Carr have taken over as joint managing directors of Plant Protection Ltd. to replace Mr. S. W. Cheveley who, as we announced last November, has been appointed chairman of the Central Agricultural Control of I.C.I. Ltd.

Collectivised Agricultural Development in the U.S.S.R.

THE schemes for collectivised agricultural development in the U.S.S.R. under the latest 15-year plan was the subject of a public symposium organised by the Society for Cultural Relations with the Soviet Union at Battersea, London, recently under the title 'Man Conquers Nature,' in which a number of speakers took part. Although most of the speakers were obviously biased in favour of Soviet methods and doctrine, some interesting points emerged. The lecture was followed by a display of films illustrating some of the points discussed.

Dr. S. M. Manton, F.R.S., who opened the meeting, took as her subject 'Biology and the Construction Schemes.' She pointed out that the final object of the work now in hand is to change the climate of the steppes and to reduce the velocity of the winds, which, in their uninterrupted race across the plains, speed soil erosion. Belts of trees are being planted along the line of the rivers and canals—3,300 miles mainly of oaks and poplars—and a machine has been developed to plant seedlings.

Dr. Manton gave figures relating to the Stalingrad and Kuibyshev hydroelectric schemes and to the Don-Volga Canal. In the Volga schemes alone 26 towns would be flooded, and the lake behind the Kuibyshev dam would be 310 miles long and 10 miles wide. Construction would be completed by 1955-56. Alongside the engineering and agricultural progress, fisheries are being developed.

Mr. J. Dunman, speaking on 'The Transformation of Agriculture,' focused his opening remarks on the erosion question. He emphasised the dual purpose of the protective belts of trees— soil retention and wind-speed reduction. The steppes are, in fact, being divided into giant rectangular fields. Seventy million acres, he said, would be irrigated by the new dams and canals. It was intended to increase wheat production by 8,000,000 tons. Permanent ditches to link the irrigation schemes would be an inconvenience to the machines used in cultivation and high-speed trenches have been developed to open waterways as required and backfill them to make way for the mechanised harvesters. Rotation of crops is planned to allow one year fallow in three, with grass crops ploughed in to provide humus and to increase the water-retaining properties of the soil. Stock-carrying capacity would be increased five or six times. Vegetables are being introduced into the rotation, and there would be no specialised market gardens. Much of the inspiration came from W. Williams and his book, *Principles of Agriculture.*

Mr. F. le Gros Clark felt there had been a lot of frightening talk about figures of the doubling of the world's population in the last century, and the estimate that it would double again in the next 75 years. Though some soils had eroded down to bare rock, most could be nursed back again to pro-productivity by using the correct methods. But the matter must be treated with urgency; there must be no delay. Irrigation and afforestation alone were not the answers: all the workers must move closer to science. There must be training to fit them to handle the great schemes under way.

He had no doubt that experts in India, Pakistan, Iraq and Egypt were taking note of what was going on in Russia; he would sum it up as a combination of the farm co-operative plus control of water resources. Some compulsion might be necessary to establish agriculture on this basis; some steps were already being taken in this direction (outside U.S.S.R.) by certain governments and people. Education in Russia was proceeding through the collectives.

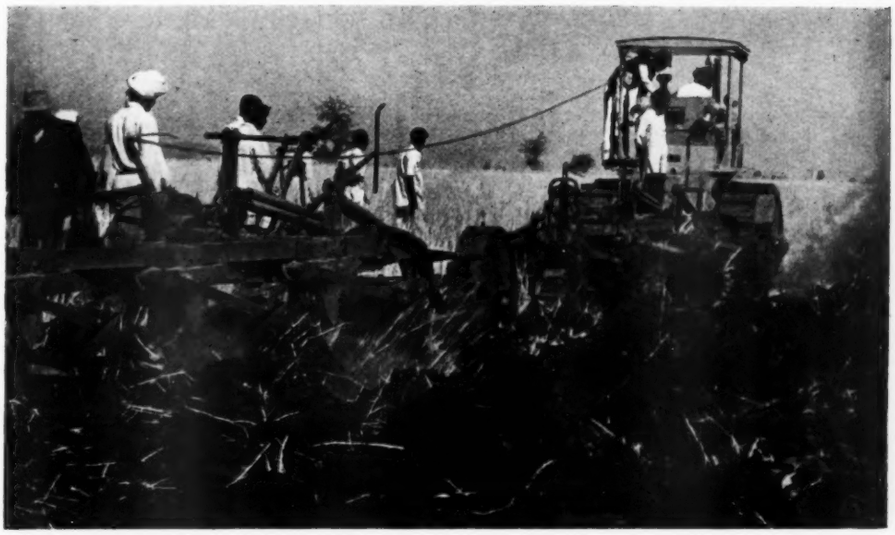
There are many plans afoot in other parts of the world, and many people are anxious to emulate the Soviet schemes. They realise that soil and sun are useless without water and are bringing about what had aptly been termed the 'Hydrological Revolution.' In this Russia was just a few steps ahead; it was simple for others to understand the lessons of her effort. Mr. le Gros Clark closed by emphasising the importance of educating the peasants to the new methods.

Mr. Brian Pearce, speaking in place of Mr. Andrew Rothstein, followed with a review of industrial aspects of the work. He gave figures of power production and pointed out that Russia is working for a state where the distinction between manual and mental labour will be abolished by mechanisation. Mrs. Eleanor Fox subsequently discussed 'Human Aspects of the Schemes,' basing her speech on material supplied by the novelist Boris Polevoi.

Professor Bernal, summing up, stated that such work had never before been tackled on this scale or under these conditions. The construction schemes must have a world influence. He pointed out that this revolution of peace could only be brought about by the integration of science and industry in the collectives.

Land Reclamation by India's Central Tractor Organisation

*In 1947, the Ministry of Agriculture in India bought 305 diesel crawler tractors from the surplus of the United States forces in India. That was the beginning of the Central Tractor Organisation of the Government of India, which has reclaimed to date over 400,000 acres on a non-profit basis at a cost of around 78 shillings an acre. The following account * outlines the functions, achievements and methods of operation of the organisation.*



Mechanisation of Indian agriculture by the C.T.O. The reclamation work is estimated to cost around 78s. an acre

IN the great battle for food self-sufficiency, the Central Tractor Organisation of the Government of India has played no small part since it came into existence in 1947. It has, in fact, won a few victories all along the front, especially in its land reclamation operations which reached a record figure of 400,000 acres.

This Organisation, which brings, in a way, mechanisation to Indian agriculture, has travelled a long way from its initial start at the end of World War II.

A large number of caterpillar bulldozers and tractors used during the war in building the famous Ledo Road, were acquired by the Government of India from the U.S. Army authorities, and along with them the services of Major J. H. Connors, a U.S. engineer.

This Organisation was set up as a semi-attached service organisation to the Central Department of Agriculture, Government of India, and consisted of four main Divisions: Workshop, Operations, Training and Research.

Ploughing—reclamation

As an integral part of the Grow More Food campaign, the tractors were originally to be used for ploughing. But, before long, the idea occurred that they could be used to reclaim Kans-infected land, about 10 million acres in Uttar Pradesh, Madhya Bharat, Bhopal, Madhya Pradesh and Western Vindhya Pradesh. This experiment of using the machines for reclaiming land was a great success.

For this purpose an efficient workshop was set up, where Major Connors trained the nucleus of technicians and engineers. With 90 machines, the C.T.O. reclaimed about 32,500 acres in 1948. The figure rose to 72,000 acres in 1949 with 180 tractors on the field. The success was so encouraging that the Government sanctioned the purchase of 375 tractors and the necessary land clearing equipment, transport vehicles and ploughs to reclaim three million acres over a period of seven years.

Administration and welfare

The International Bank for Reconstruction and Development, Washington, after examination by its experts, sanctioned a 10 million dollar loan for India from which 180 machines were purchased at the outset; 90 of these machines went to work late in the 1950 season. Later, an order for 60 more tractors was placed, and these joined the reclamation operations of the C.T.O. in February 1951.

The C.T.O., with its headquarters at Pusa, New Delhi, is now under the control of a permanent Civil Servant. It is in the immediate charge of an expert tractor engineer designated as chief engineer, who, in turn, is assisted by a band of trained engineers and assistant engineers. It has a staff of 2,000 of whom 1,600 are technical personnel.

The land reclamation work of the C.T.O. is carried out by 16 units, each with a complement of 15 tractors. Every two units are in the charge of an assistant engineer who has a trained man risen from the ranks as a mate. No direct recruitment of assistant engineers is made and those who occupy the position are men who have come up by sheer dint of hard work and technical skill. The assistant engineer is assisted by a staff of 60, including six mechanics. Each unit has its own mobile workshop so that all minor repairs are done on the field itself or at the base camp.

The tractor drivers employed by the C.T.O. are the best paid men of their class in India. Including allowances they get about £15 a month. Those engaged in operations in the field are given two Sundays as compulsory holidays and are allowed to work on the remaining two Sundays if they so desire. In that case, in addition to their normal monthly pay, they receive as overtime, double their daily wages.

Workshop

A heavy tractor repair workshop has been set up at the Indian Agricultural Research Institute. Its main function is to keep the Organisation machinery in proper working order.

The field units send tractors to the main workshop only for major repairs. This workshop usually takes 10-15 days to overhaul an engine completely, if some spare parts have to be manufactured. If, however, no spare parts are required the workshop could overhaul three or four engines every week.

* From *Indian Trade and Industry*.

The workshop has its own power house and apart from repairing four or five tractors that come to the assembly section every day, it also undertakes the manufacture of spare parts for ploughs. There are about 20 men in the assembly section and about 180 in the machine shop and other departments of the workshop.

Operations

The primary function of the Organisation is to assist the state governments in land reclamation work for which heavy power-operated machinery is essential. For this purpose various units, each consisting of about 15 tractors and associated heavy implements, are organised. Each unit is further supplied with trained operators, a full-equipped mobile workshop capable of rendering service to the operating machinery in the field and transport for carrying supplies. Some units are also supplied with bulldozers and at least one hyster gear, one scraper carrier and a motor grader for land levelling work where necessary.

When a request is received from a state government, a team of representatives from the C.T.O. and the state government concerned, inspect the site to find out whether the land is capable of being reclaimed with tractors. Only when the C.T.O. officials are completely satisfied that the project is feasible is the request of the state government complied with. No private request for help in land reclamation is accepted by the C.T.O.

From October to December, when it is off season for land reclamation, the tractors are employed in preliminary land clearing and levelling on the sites which will be reclaimed in the next season. During next season it is expected that four units will work in Bhopal, Uttar Pradesh, Madhya Pradesh and Madhya Bharat.

Training

Along with the central workshop, a tractor and power operated agricultural implements training centre has also been started. The services of this training centre were made available to state governments and private parties from April 1948. The personnel trained are operators, mechanics and assistant engineers.

Under the Point 4 Programme, two divisional agricultural engineers of the C.T.O. have recently gone to America for specialised training. One of them will study tractor management for six months and the other machine shop practice for a period of one year. All the expenses in this regard are borne by the State Department of the U.S.A.

Cost of reclamation

The C.T.O. has now 400 tractors, which include 240 new heavy machines recently purchased and about 160 old ones. With the help of the various tractor units, the minimum acreage which is considered economical for reclamation is about 20,000. From the experience gathered, the cost of reclamation, including all expenses, works out at about 78s. per acre.

Reclamation—five-year plan

The first part of the plan, which envisages additional irrigation of about eight million acres, further hopes to add four million acres to cultivation from fallows and 1½ million acres from land reclaimed by the C.T.O.

In the opinion of the authors of the plan, an increase in the production of commercial crops is expected in the ordinary course, in view of the favourable factors which prevail at present and appear to be likely to continue. An increase in the production of foodgrains will, however, require positive methods of assistance to the farmer. The following statement indicates the different types of measures which are envisaged and the extent to which on the first estimates additional production may be secured; the table also shows the part the C.T.O. is going to play in these measures.

	Area (.000 *acres*)	*Additional Production* (.000 *tons*)
Major irrigation projects	8,712	2,272
Minor irrigation schemes	7,621	1,932
Land improvement and reclamation schemes: C.T.O. 1,500; Cultivation of fallow lands 4,000; Other land improvement schemes 1,905	7,405	1,524
Manure and fertiliser schemes		584
Seed distribution scheme		370
Other schemes		520
Total		7,202

The C.T.O. is only the beginning of the end—the mechanisation of Indian agriculture. It will play a leading part in the campaign for growing more food crops. The extra yield for every acre of land reclaimed by the C.T.O. is nearly one-third of a ton per acre. This is no small achievement, for in the case of fallow land, this represents a net addition to the food resources of the country.

Indian Central Coconut Committee

Speaking at the 14th meeting of the Indian Central Coconut Committee, which was recently held in Calcutta, Sardar Datar Singh, President of the Committee, said that there are at present 1½ million acres of land under the coconut crop in India, producing about 3,433 million nuts annually. The primary aim of this Committee was to step up coconut production and to this end research and development schemes are being financed.

Since the Committee was set up in February 1945, nursery schemes for supplying coconut seedlings have been inaugurated and are now proving very popular. The organisation of the Central Coconut Research Station at Kayangulam is slowly being completed; the full complement of staff has almost been reached, but the station has yet to be provided with laboratory equipment, gas, water and electricity.

The Director of the Central Coconut Research Station, Kasaragod, who has surveyed possibilities for improved coconut cultivation on the Andaman Islands, recommended the resuscitation of existing coconut plantations and the starting of new ones, adopting scientific methods of cultivation. Regulated markets for copra have been set up in Mysore State and Malawar district, and are in the process of being set up in the South Kanara and East Godavari districts.

Grade specifications for coconut oil and standard contract charges for milling copra as prescribed by the Committee have been brought to the notice of the trade, but there has been no indication that they have been adopted.

The President of the Committee regretted that the Committee's revenue from the coconut cess has fallen off considerably, mainly due to tardy remittances of amounts collected. Hopes were held out for better methods of collection in the future.

Disappointing London Tea Prices

Addressing the Ceylon Amalgamated Tea and Rubber Estates Ltd. recently, Mr. W. H. Miles said that since the London tea auctions were resumed last April prices have been disappointing and the position is not likely to improve while rationing, price control and subsidies continue. It has now been decided to sell half the crop in Colombo and half in London. The Ceylon Government, he said, is proposing to establish export duty on a sliding scale according to price, but in the case of a commodity like tea the working is likely to prove difficult.

The Economics of Coffee, Tea and Cocoa

MR. V. D. WICKIZER has rendered a notable service by the preparation of a book,* which describes and analyses the political and economic factors which affect the production and marketing of what may be termed the three major beverage crops, coffee, tea and cocoa, and especially the confused and complicated conditions which have arisen in this connection as a consequence of and a sequel to the Second World War. Mr. Wickizer is well known as an economist who has made the study of these commodities peculiarly his own; his two earlier books, *Tea Under International Regulation* and *The World Coffee Economy*, are accepted as standard works.

In the present book he has consolidated his earlier studies into one volume, added a survey of the position in regard to cocoa and a concluding section dealing with the problems of all three industries on a comparative basis with a valuable final chapter on the evolution of tropical crop production.

Coffee

The longest section is concerned with coffee and preponderatingly with the vicissitudes of the crop in Brazil which was for long the dominating influence in the world coffee situation. It is remarkable that notwithstanding much of the coffee in Brazil is produced on large estates, its quality is below that from most other parts of the world. Generically Brazilian coffees are classed as ' hard ' and realise lower prices than other categories which are classed as ' mild.' The difference is not due to variety—the bulk of Brazilian coffees are derived from the arabica species which, when properly prepared, can produce the highest grades—rather is it attributable to defective methods of preparation. The Brazilian coffee industry is surely unique among tropical plantation crops in that planters instead of endeavouring to improve the product by better cultivation and processing based on research, have consistently relied mainly on Government intervention to protect them by influencing world prices, relying for this on the predominating position of Brazilian coffee in world markets. The result after close on half a century cannot be said to have been very successful; as the writer says on p. 134: '*the outside observer cannot help being impressed with the fact that most of Brazil's coffee problems derive from over much government influence, regulation, control and subsidisation.*'

There have been endless devices, ranging from the ' valorisation ' scheme of the early part of the century, through a variety of subsidising schemes, and the planned destruction of millions of bags of coffee in an effort to reduce stocks, to more dubious practices such as the witholding of reliable information regarding stocks and the ' slanting ' of information about developments with a view to influencing prices.

The war heightened difficulties and led to the inauguration of the Inter-American Coffee Agreement and the setting up of the Inter-American Coffee Board at the instigation of the U.S.A. Under the influence of this and with a continuing rise in prices the situation improved, and the vast stocks which for many years hung like a cloud over the industry were gradually liquidated. The agreement was terminated in 1948 as the prevailing outlook was considered sufficiently favourable to warrant such a step.

Since then prosperity has been maintained, but the outlook on the long term seems uncertain. At the time of its dissolution the Coffee Board defined the needs of the industry as including the setting up of adequate statistical and information services, the provision of research and the application of technological knowledge. It remains to be seen how far this will be achieved.

Meantime the possibilities of expanded coffee production in Africa and elsewhere must be considered. At present the output is small compared with that of the Western Hemisphere, but the scope for expansion is enormous. The provision for research and development in East Africa and elsewhere is at present small but it is efficiently organised and with the growth of the East African Agricultural Research Organisation may be expected to expand; the possibility must not be overlooked that with lapse of time African production may become more and more a dominant factor in this situation.

Tea

The tea industry provides a considerable contrast with coffee. In India, Ceylon, and, before the last war, in Indonesia, the industry was organised predominantly on an estate basis. Cultivation and manufacture were efficiently carried out, there was adequate provision for research, while good statistical and information services existed. In China and Japan, on the other hand, the industry was on a basis of small ownership but tea exports tended progressively to diminish, more and more of the products being consumed locally.

Overproduction of black tea and the depression of the 1930's led to the evolution of the International Tea Regulation Scheme, probably the most effective of all the international commodity restriction schemes. The machinery for its continuation is still in being although the need for it temporarily disappeared with the occupation of the Indonesian territories by Japan which cut off supplies from this territory.

* *Coffee, Tea and Cocoa*, an economic and political analysis, by V. D. Wickizer, pp. xiii-497; a publication of the Food Research Institute of Stanford University. Stanford University Press (London: Geoffrey Cumberlege), 1951, 40s.

The shortage was made good by coarser plucking in Indian and Ceylonese tea gardens. Recovery in Indonesia is still very far from complete and while this continues the situation of the other black tea producing regions is reasonably assured.

With the resumption of full-scale tea production in Indonesia and the expansion of tea growing in East Africa, however, over-production may once again make its appearance and the resumption of international control may again become necessary.

Cocoa

Cocoa is again a contrast to tea and coffee, being predominantly a peasant industry largely concentrated in West Africa and in Bahia in Brazil. The predominant consideration is disease control and on success in this direction the future of the industry is largely dependent. Unlike tea and coffee, although there have been in the past problems of over-production, there has never been any attempt at production control schemes although the possibility of their introduction was at one time discussed.

In West Africa, during the war, difficulties in marketing were overcome by the Government controlled marketing schemes which ensured a fair price to growers and prevented excessive amounts of cash passing into the hands of growers without an adequate supply of trade goods to absorb it. These marketing schemes have been revised and consolidated on a permanent footing since the war. To combat the disease problem there has been considerable extension of research coupled with executive action on a large scale, the tenor of which has exhibited considerable fluctuation owing to political pressure.

Future outlook

In the concluding chapters the author considers the implications of the present position and the outlook. He discusses the prospects for the continuation of large-scale estate agriculture and the opposing claims of peasant production. He apparently considers that in the major black tea countries the plantation system is likely to be maintained but that local interest will probably ultimately replace foreign ones. In regard to peasant development he is very guarded and contents himself with listing the views of various opposing authorities.

To the present reviewer it seems obvious in the light of past experience that, on their present basis, the outlook for the predominantly peasant industries is precarious. Only from the west can come the knowledge and the skill necessary to enable the various technical difficulties of cultivation, processing and disease control to be overcome, and the future is bound up with the problems of applying them. The earlier *laissez faire* policy which allowed small peasant holdings to spring up haphazardly over enormous tracts of country creates automatically a set of conditions which makes it immensely difficult, if not downright impossible, to apply modern methods effectively. If peasant production is to extend and prosper, therefore, it must be on a basis of an adequate measure of overall control through government or *quasi* government agencies, which will facilitate the application of modern methods. These will decide where peasant holdings are to be located and the manner in which they are grouped. They must also be provided with powers to ensure that cultural operations are carried on in accordance with the requirements of good husbandry and sanctions applied in the event of persistent non-compliance.

There must also be adequate provision for the supply of materials, tools and implements, for research and advice, for financing cultivators and for the processing and marketing of produce. If this can be achieved there is no reason why the tropical peasant cultivator should not steadily improve and increase his contribution to production in the tropics; if not he will no doubt continue as a low cost, low level producer, but it is vain to hope that he ever will achieve the higher standard of production and living which is so very much to be desired. The task of bringing about these changes is one of great difficulty but there are at least some signs that this view is becoming accepted in many quarters.

Conclusion

Be this as it may, there can be no doubt that the author is to be congratulated on a masterly survey of these three important tropical agricultural crops, which no one connected with them can afford to neglect. The work is admirably documented throughout with copious extracts from papers and reports by numerous authorities, while there are a number of valuable statistical appendices and one dealing with the cost of production of coffee and tea.

H.T.

Photos of coffee and cocoa on p. 111 by courtesy Brazilian Government Trade Bureau; the photo of tea by courtesy The Tea Centre, London.

Our Contemporaries

Below we list a selection of articles appearing in the March issues of some of our sister journals in the Leonard Hill Technical Group :—

Food Manufacture : 'The Baking Industry,' by Dr. F. Aylward.

Manufacturing Chemist: 'Essential Oil Analysis,' by S. Collett.

International Chemical Engineering: 'The Chemical Preservation of Wood' (summaries of papers read at the first annual conference of the British Wood Preserving Association).

Paint Manufacture : 'The Examination of Varnish Making Vegetable Oils,' by Dr. H. W. Chatfield.

Muckshifter and Public Works Digest: 'Piling for Civil Engineering Projects,' by R. J. Salter.

Beginning with the April issue, the title of our associated journal, **International Chemical Engineering** will be changed to:—

Chemical and Process Engineering

This new title expresses more accurately the scope and purpose of this journal which is to record and illustrate progress in the design and development of chemical plant and operations for all industries throughout the world.

Successful Cotton Irrigation in Baluchistan

Cotton has for the first time been successfully grown in Baluchistan, reports the Pakistan High Commission. Thirty-two maunds per acre of cotton have been obtained from land under perennial irrigation, compared with 15 maunds per acre from land irrigated by natural flood waters.

In the Loralai district, where the high yields have been obtained, American varieties of cotton were grown. The average yield of cotton in the Punjab and Sind, where there is mixed cultivation with perennial irrigation, is only 10 maunds per acre.

Baluchistan landowners have become very keen on cotton prospects and are now converting areas to cotton from jawar, a roughish food grain on which the financial return is not very high. In Baluchistan, it was reported, 6,000 acres of land are immediately available for cotton, with flood water irrigation. Mechanical aid will be needed for making bunds and increasing the yield by regular irrigation.

Florida Kenaf

An area of central Florida is being developed for Kenaf production by the American Kenaf Corporation, which expects a heavy demand for this jute substitute under present conditions of jute supply.

NEW BOOKS

Selected Writings of N. I. Vavilov

The Origin, Variation, Immunity and Breeding of Cultivated Plants. Translated by K. Starr Chester. Pp. viii and 366. Chronica Botanica, Waltham, Mass. (London, W.C.2.: Wm. Dawson & Sons Ltd.), 1951. $7.50.

In spite of their world renown, Vavilov's achievements have in the main only been known to the English-reading public through summaries and reviews; this competent translation of his selected writings, which were first published in 1935 as part of a symposium 'The Scientific Bases of Plant Breeding,' therefore remedies an outstanding deficiency.

Vavilov's short introductory essay defines the general scope of crop breeding. Stressing the need of using several sciences—genetics, cytology, ecology, systematics, plant geography, the biology of flowering, biochemistry, physiology and technology—it prepares the reader for Vavilov's comprehensive approach, wherein lay the key to his pioneering successes.

In 'Phytogeographic Basis of Plant Breeding' Vavilov propounds his well-known theory on the origin of cultivated plants and describes the results of extensive collecting expeditions in Asia, Africa, Southern Europe, and the Americas. Vavilov aimed at nothing less than a global inventory of cultivated crop varieties and wild related forms as the basis of long-term programmes of breeding wheat and other important crops in the U.S.S.R. According to Vavilov, the greatest heritable diversity of a cultivated crop occurs in the geographical centre where it evolved. Rich material for the breeder's purpose can therefore be found in the remoter regions, where primitive agriculture has persisted and cultivated plants still grow in their primary indigenous state. As the result of a vast amount of detailed study of collections from such regions, Vavilov postulated eight main centres of origin, involving numerous cultivated species. In some cases Vavilov's suggested centres of origin have been disputed, but the essential value of his theory remains. Vavilov concludes: 'We have barely begun the systematic study of the world's plant resources and have discovered enormous untouched reserves, unknown to scientific breeders in the past. The tremendous potential source of species and varieties requires thorough investigation employing all the newest methods. . . .' In spite of the progress since made by breeders all over the world, Vavilov's words retain their challenge.

'The Law of Homologous Series in the Inheritance of Variability' formulates a concept which was one of the important theoretical foundations of Vavilov's explorations. The fourth paper, 'Study of Immunity of Plants from Infectious Diseases,' surveys the literature on genetical and other aspects of immunity and resistance to diseases and pests.

The work of Vavilov and his colleagues opened up a new era in wheat genetics and breeding, particularly in the crossing between species and genera. The second half of this volume is taken up with Vavilov's exhaustive treatise, the 'Scientific Bases of Wheat Breeding,' in which he reviews the results of genetical and breeding work not only in the U.S.S.R. but in other wheat-producing countries, discusses the 'world wheat potential' discovered through the Soviet expeditions, and examines in detail the basic aims of breeding in the U.S.S.R.—aims which in their various forms are the perennial problems of all wheat breeders.

THERESA ASHTON

Mineral Nutrition of Plants

Edited by Emil Truog. Pp. 469. University of Wisconsin Press, 1951. $6.

This book has been published in celebration of the 100th anniversary of the foundation of the University of Wisconsin. It comprises a series of 18 papers contributed at a symposium organised at the suggestion of Mr. D. D. Long of the Plant Food Research Committee of the National Fertilizer Association, and held at the University during the anniversary year. The programme of papers was drawn up by a committee of 11, with Professor Truog as chairman, representing six national scientific societies in the U.S.A. and three other organisations with interests in the subject.

The 18 contributors were selected as authorities in their special fields and to provide a logical sequence of papers beginning with the soil and passing on successively to the subjects of absorption and translocation of mineral nutrients by plants, the role of the mineral nutrients in plant nutrition and, finally, the modifying influence of environmental factors, such as light and soil moisture, on nutrition. Two papers were included to illustrate the complexity of nutritional problems in practice. It is stated in the preface that one of the primary objections of the symposium was to provide an opportunity to present the latest news regarding the availability of mineral nutrients and the mechanisms of absorption and translocation of these nutrients in plants.

The list of the 22 contributors is an impressive one, and the quality of the 18 papers is uniformly high.

The papers are arranged in six sections, each of which comprises complementary contributions in a special field and will enable the specialist reader to refer easily to papers of particular interest to him.

It is difficult and even invidious in reviewing a composite book of this kind to attempt to select chapters for special mention, since readers engaged in the different fields covered will have their own individual preferences.

For the reviewer each chapter contained much of interest, and in each the subject matter is thoroughly up-to-date.

Those concerned in estimating potential world food production will at least find much food for thought, even if they disagree, in the optimistic views expressed in the opening chapter by Dr. Kellogg and Dr. Orvedal in their contribution on 'World Food Possibilities and Fertility Status of our Soils.'

For soil specialists there is much of interest in the papers concerning factors affecting nutrient availability in soils by Truog, Marshall, Overstreet and Dean, Jenny, Page and Bodman, and Norman, and in the more practical contributions of Boynton and Hester on problems of fruit and vegetable crops respectively.

The subjects of absorption and translocation are dealt with by Broyer, Burström and Biddulph, this being the section specially referred to in the preface.

The section on the role of minerals in plant nutrition comprises three novel and stimulating papers by Arnon, Loehwing and Steinberg respectively, the views of Steinberg regarding the connection between mineral deficiency symptoms and protein metabolism being of particular interest.

In the last section two papers by Withrow, and Wadleigh and Richards, discuss the effects of light and soil moisture on nutrition, and a third paper by Clements describes an anlysis of environmental factors determining the growth and yield of sugar cane in Hawaii, and the author's method of controlling vegetative growth and yields with guidance from plant tissue data, particularly the contents of moisture, phosphorus and potassium during the growth cycle.

This book is an important one, and it is appropriate that it should mark the centenary of the University of Wisconsin whose soil department has contributed so much to modern soil science.

T. WALLACE

Reclaiming Land for Agriculture

By Moses Griffith, J. F. H. Thomas and R. Line. With an introduction by Sir George Stapledon. Pp. 119, illustrated. Crosby Lockwood, London, 1951. 12s. 6d.

To quote from the publisher's announcement, ' this book is devoted to the detailed consideration of land reclamation on three distinct and contrasting types of land in the United Kingdom,' *viz.:* Hill and Moorland, the Chalk Uplands, and the Fens and Silts, a separate section being devoted to each. Each section is written by an expert on the particular aspect and the three sections are preceded by a short introduction by Sir George Stapledon which correlates the whole and reviews the general principles involved.

Its appearance is timely since in present conditions so much depends on the efficient use of limited land resources to ensure the maximum return from them. Each aspect is treated in detail and a concise picture given of the problems involved, the methods employed and the subsequent maintenance of the reclaimed areas.

In his introduction Sir G. Stapledon emphasises the importance of preliminary surveys to determine the type of farming practicable on the reclaimed or rehabilitated land. He also stresses the importance of proceeding in an orderly fashion, and planning reclamation and rehabilitation to cover either a whole district or at least a sizeable group of contiguous farms, as opposed to haphazard operations on individual properties. The same principle, incidentally, underlies rehabilitation in the U.S.A. in the soil conservation campaign and has led to the concept of soil conservation districts.

The methods of farming reclaimed land go to the core of the whole matter, particularly on the lower grades where the interrelation of farming systems, rotations, types of livestock and the work of reclamation, counts for so much. It is a melancholy spectacle to see areas of reclaimed land gradually deteriorating owing to improper or defective husbandry.

The various sections are attractively written while the illustrations portray many points brought out in the text. An appendix summarises the legislative proposals for marginal land reclamation in the U.K. as outlined by the then Minister of Agriculture to the House of Commons in July 1950.

The work can be cordially commended to all interested in land reclamation not only in the United Kingdom but also in other parts of the world.

H.T.

New Publications

The following books, published recently, are available from the Book Department, WORLD CROPS, Leonard Hill Ltd., 17 Stratford Place, London, W.1.

Agricultural Resources of China, by T. H. Shen. Pp. 408. Oxford. 32s. 6d.

Important Grassland Plants of Kenya, by D. C. Edwards and A. V. Bogden. Illustrated. Pp. 124. Pitmans. 20s.

Mineral Deficiencies in Plants, Diagnosis by Visual Symptoms of. A colour atlas and guide. H.M.S.O. 35s.

Photosynthesis and Related Processes, by E. I. Rabinowitch. Illustrated. Pp. 615. Interscience. 120s.

Principles of Weed Control, by G. H. Ahlgren, G. C. Klingman and D. E. Wolf. Illustrated. Pp. 368. Chapman & Hall. 44s.

The Swedish Seed Association. Organisation, Methods and Results in Plant Breeding, by A. Akerman. Pp. 15. National Institute of Agricultural Botany. 2s.

Heterodera

The Cyst-forming Species of Heterodera. By Mary T. Franklin, Ph.D. Pp. 147. Illustrated. Commonwealth Agricultural Bureaux (Technical Communication), 1951, 18s. 6d.

Plant nematodes have of late years come in for much attention and accordingly this authoritative book on the cyst-forming eelworms is welcome.

The property of certain species of Heterodera of producing encysted females which can exist unchanged in the soil for many years has been the subject of much research. *Heterodera Schachtii* was the first species recognised; it was discovered by Schacht infesting the roots of sugar beet in 1859. Since then the number of recognised cyst-forming species has been much enlarged, among the most important being the potato eelworm, *H. rostochiensis.*

In this book the author deals with eight species of Heterodera, covering the life history, morphology, damage done by and control of each. The accounts given only extend up to the end of 1948 and as, during the last two years, some important advances have been made these accounts are not entirely up to date. For example, no information is given of the more recent work of Todd and his co-workers on the diffusates from the roots of host plants, although earlier work is faithfully dealt with.

This was presumably unavoidable, bearing in mind that the book was two years in the press. Otherwise it admirably upholds the high standard of C.A.B. publications, while in general presentation, binding and so on it is a marked advance on some of its predecessors.

It is well illustrated with 21 plates and there is a very full bibliography. It is, of course, a book for the specialist rather than for the farmer, although it is lucidly written and could be read with profit by anyone with a minimum of technical knowledge.

Plant Breeders of the Future

By Gordon Haskell. Pp. 34. The Biological Press, London, 1950. 3s.

This little brochure is based upon a lecture given by the author to students at the John Innes Institute and at the Connecticut Agricultural College. It is mainly intended for workers in the field of plant genetics who have passed through a university training in botany but have had little experience in practical plant breeding. It emphasises how modern methods of plant breeding are rapidly changing through the introduction of new techniques and how thorough knowledge of the scientific principles of inheritance is essential. It gives examples of the use of hybrid vigour in breeding tomatoes and sweetcorn, the use of colchicine for the production of polyploids and selection for cold hardiness. It also mentions the recent deplorable entry of politics into plant-breeding practice and advises a comparison of Lysenko's recent writings with those of Mendel and Darwin. There is also a reading list for students.

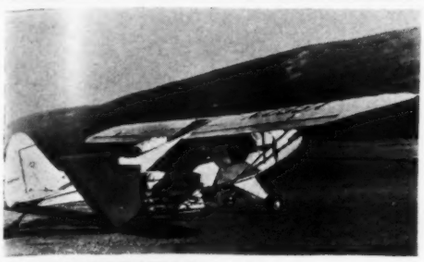
It should prove useful to the audience for which it is intended.

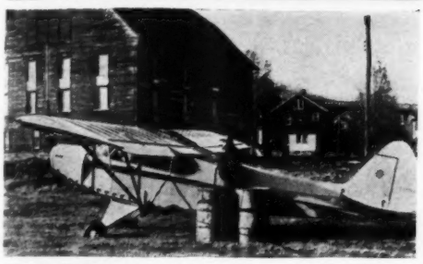
To Authors and Readers

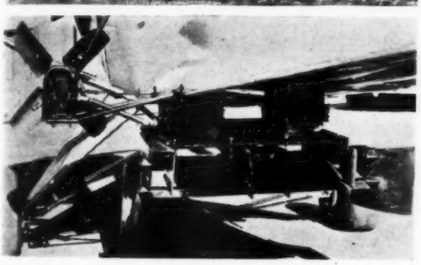
The Editor and Publishers of WORLD CROPS will be glad to consider manuscripts of books submitted for publication. We already publish a number of books on technical subjects, all of which find a world sale and most call for regular reprints and new editions.

Books of a non-fictional type in any language by any publisher can be supplied by the Book Department of WORLD CROPS.

FARM MACHINERY





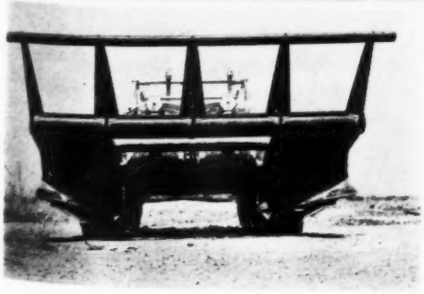


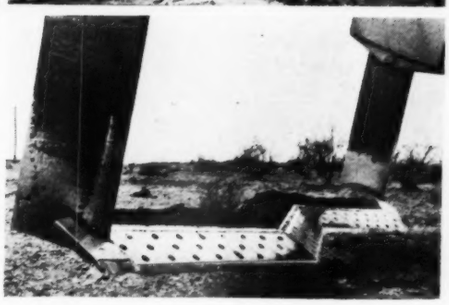
New Agricultural Aircraft

Following three years of development work carried on by Piper Aircraft Corporation engineers, the new agricultural model, the PA-18-A, has been put into production by Piper at its Lock Haven, Pa., plant. It has been developed from the basic Piper Super Cub, 125 h.p. general utility aircraft, and specifically built for aerial application of agricultural chemicals. It can carry up to half a ton of chemicals and spray up to 220 acres of crops in 45 min.

The new model is available as a duster, sprayer or as a convertible model. The sprayer has two streamlined booms under each wing, each containing 12 spray nozzles. The total of 24 dispersal units puts out a swath over 50 ft. wide. Dispersal can be adjusted for coverage of from ½ to 5 gal. per acre, through adjustment of the nozzle orifice and pump pressure. As a duster, the PA-18-A features a dispersal unit which embodies both slots and vertical scatter plates, a unit which is effective in spreading the dust over a swath nearly 50 ft. wide and, with flaps extended, in providing a good penetrating down wash. Uniform flow is provided by double agitators at the bottom of the hopper, driven by a propeller in the slip stream. Conversion from sprayer to duster or vice-versa can be accomplished in 1½ man-hours. Fuel consumption during normal agricultural use amounts to about 6 gal. per hour.

The Piper PA-18-A (*top to bottom*)**; filling the 18 cu. ft. hopper which is removable and capable of holding 110 gal. of liquid. For spraying, 24 nozzles give a 50-ft. swathe at ½ to 5 gal./acre. The slotted double-gate return, for dust dispersal, has lateral dispersal plates and control flaps**





Rear-Mounted Hammermill

The ScotMec hammermill has been approved for use with the Fordson Major tractor as a rear-mounted attachment. It is bolted to a support frame and picked up by the power-lift of the tractor, thus becoming fully mobile. The belt is automatically tensioned by lowering the mill ready for grinding. The mill, which has been tested by the N.I.A.E., will grind 35 cwt. of oats into cattle feed, or 15 cwt. into pig feed, per hour.

ScotMec hammermills, of which three sizes and three types are made, giving nine basic combinations, are manufactured by Scottish Mechanical Light Industries Ltd., Ayr, Scotland.

A Texas Giant

A machine that takes a 16-ft. slice beneath the soil to control brush and re-establish native grasses for grazing is the 52-ton twin Caterpillar D.8 tractor equipped with the Holt funnel dozer in front and Holt root plough behind, shown in the accompanying photographs. The construction of this giant land-clearer was, incidentally, carried out by two dealers in Texas. Cable controls operate the dozer and plough, both of which pivot on trunnions attached to the track roller frames of the high-clearance twin tractor. The dozer can be raised or lowered by the operator and is claimed to be capable of knocking down 40-ft. trees and underbrush. The root plough cuts roots and stumps below the soil surface, the whole equipment clearing land such as that shown in the photographs at a rate of four acres an hour.

Readers may remember the article published in WORLD CROPS a year ago (Vol. **3**, 3, pp. 89-94, March 1951) on land-clearing practice in Tanganyika, where a heavier type of growth had to be cleared and a method of chain clearing was evolved in which three crawler tractors were used, two of them dragging a heavy anchor chain between them and the third following behind fitted with a tree dozer arm to push down any obstacles which did not yield to the combined pull of the two leading tractors.

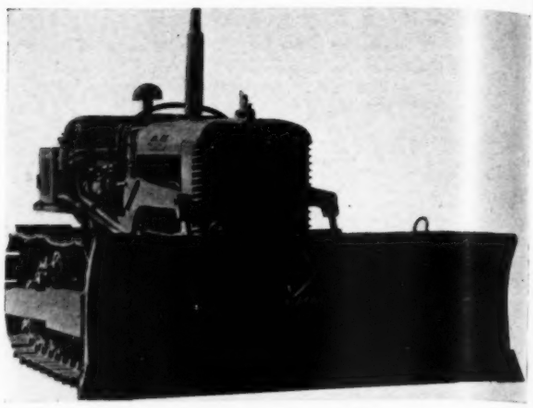
Other machinery for land clearance and initial cultivation has been discussed by P. H. Southwell in WORLD CROPS (Vol. **1**, 3, pp. 107-110, November 1949).

(*Above, left and right*) **The 52-ton machine in action, seen from in front and behind.** (*Below, left and right*) **Close-ups of the massive funnel dozer and root plough**

'Dragon' Production

Exports of the 'Dragon' crawler tractor now reach over 17 countries overseas, according to Colonel A. S. Osborne, O.B.E., M.C., Managing Director of Messrs. Vivian Loyd and Co. Ltd., speaking at the firm's annual dinner recently. Since the introduction of the 'Dragon' just over a year ago production of the tractor has increased by 200%.

The makers are now fitting one type of diesel engine, the 36 b.h.p. Dorman 4DS, with governed speed of 1,600 r.p.m.



'Dragon' crawler tractor fitted with a 36 h.p. Dorman 4DS diesel engine

Caterpillar Changes

Two Caterpillar Tractor Co. executives have been named to direct expansion of facilities and operations at Joliet, Illinois, and York, Pennsylvania, according to an announcement by Louis B. Neumiller, president of the Caterpillar Tractor Co., Peoria, Illinois. They are T. R. Farley and William L. Naumann.

Farley, a vice-president of the firm, will go to York early this year to establish a temporary office as construction of the 360,000 sq. ft. plant gets under way. Production will centre around replacement parts for 'Caterpillar' products.

Naumann, assistant general factory manager at Peoria, succeeds Farley as general manager of the Earthmoving Equipment Plant at Joliet. Expansion plans at Joliet will include a 75% increase from the present 662,400 sq. ft. of manufacturing area. New construction includes a separate parts building and additions to the present factory and heating plant.

Turkey Mechanises

In spite of lack of capital, Turkish farmers can now purchase equipment with assistance from their government. The Turkish Agricultural Bank makes advances of up to 75% of the total value of the machinery purchased; the loan is a five year one and interest is payable at a rate of 5%.

Recently the 5,000th Ferguson tractor was sent to Turkey from Britain and a short ceremony took place in London, where Mr. Kadri Rison, Chargé d'Affaires at the Turkish Embassy, broke a bottle of champagne against the crated tractor. In 1950 only 916 tractors were imported from the U.K., but in 1951 the total was 6,322.

Among those present at the ceremony were the Turkish Commercial Counsellor, Mr. H. Balkir, Mr. H. J. Lloyd of the British Agricultural Machinery Manufacturers' Export Association, Mr. H. C. Berens, Chairman of the British Overseas Engineering and Construction Corporation Ltd., and representatives of the Board of Trade and Export Credits Guarantee Department.

Touring African Markets

We are informed that Brigadier H. Fletcher, Managing Director of Drake and Fletcher Ltd., manufacturers of agricultural spraying and dusting machinery, is at present touring some of his firm's principal markets, visiting first of all South

Brig. H. Fletcher

Africa, where at Cape Town he was met and looked after by his agents, the South African Import Co. From there he went to Kenya, where he arrived in February and visited a number of estates where spraying problems exist. On March 20 he flies to Rhodesia where sole agents are still to be appointed. Messrs. Guthrie & Co. Ltd., who have represented D. & F. in Malaya for many years, are interested in marketing their products both in Northern and Southern Rhodesia. Many D. & F. machines have already gone to these territories, but the Brigadier hopes by his visit to boost his company's sales in what are undoubtedly growing markets for this type of machinery and to learn about any special spraying and dusting problems so that machines can, if necessary, be modified or redesigned to meet the local requirements.

We wish him good luck and every success in this effort to help extend Britain's export trade.

Arwell Application Machinery

The dual-purpose Arwell atomising sprayer and duster was demonstrated recently by the R. Wells Agricultural Group Ltd., together with the new Arwell Junior sprayer.

The Arwell sprayer and duster carries a 20 gal. tank for liquids, a 2½ bushel hopper for powders, and is powered by a 0.8 h.p. four-stroke engine. Two new features incorporated in the latest model are an agitator fitted in the tank and a fishtail attachment for ensuring wide distribution of dusts. Atomisation of liquids is ensured by an airblast which carries the spray away as it leaves the jet. Dry or wet dusting can also be carried out. For the former, two separate currents are used for spraying water and powder, meeting as soon as they leave the diffuser and producing a fine spray. The tractor-mounted model costs around £87, while the tractor-drawn or hand-operated machine is about £93.

The new Arwell Junior sprayer has the same engine as the larger machine and carries a 5 gal. tank. It is hand-propelled, being mounted on one rubber-tyred wheel. Complete with a 5 ft. adjustable spray-bar equipped with six movable jets this machine will cost around £70.

The spray-bar is constructed of two strips of wood between which are clamped the six nozzles. By opening apart these two strips the nozzles can be moved about to the desired width between each other. These spray-bars can also be adjusted to two different positions in height, the highest being 21 in. from the ground; they can also be fixed vertically for spraying high plants or bushes. It is claimed that this machine will cover a 180 ft. run with six jets spraying 12 in. apart, using 4 gal. of liquid.

Overseas distributors for these machines are Joseph Pyke and Son (Liverpool) Ltd., who state that Arwell machines are being exported to nine overseas countries.

RESEARCH DEVELOPMENTS

Resistance to Insecticides

WHEN in 11 countries DDT failed to control local infestations of houseflies, entomologists were not faced with a new problem; rather it was an existing question pointed in new terms, for there are reports as early as 1897 of orchard pests which had acquired resistance to kerosene-based cover sprays. In about 1911, after eight years of lime sulphur spraying, San Jose Scale was found to be no longer controlled by this chemical, although the poison was being used at 10 times the original concentration.

Resistance to polychlors

Being the first of the polychlor insecticides, DDT's failings were the first to be noticed, and in consequence this poison has had more than its share of adverse publicity; however, DDT is not the only polychlor insecticide to which insects have developed resistance. Recently one U.S. entomologist expressed the view that pure gamma BHC would last only two years before houseflies became resistant to it. This was an over-optimistic statement, because within a few months of the utterance field trials demonstrated clearly how flies in one area had not only acquired tolerance for BHC, but could also resist dieldrin. When in South Africa and Argentina, the blue tick, *Boophilus decoloratus*, became resistant to sodium arsenite dips BHC gave immediate control. But this easement did not long endure, and in South Africa now there are ticks resistant to both arsenite and BHC.

Phosphorous insecticides

Other examples are not difficult to find; red spider has evolved a tolerance for parathion and for azobenzene, while in small-scale trials it has become resistant to other phosphorus insecticides. In the United States, and possibly in the Transvaal, there are strains of citrus thrips which are resistant to tartar emetic. This resistance developed within two years of the first recommendation for its use. This was for 4 lb. of emetic per acre of citrus treated, but by 1941 12 lb. to the acre did not give satisfactory control.

Arsenates

For codlin moth the position is not so clear; one Virginian entomologist has called attention to the fact that, despite improvements in spraying gear and in the formulation of lead arsenate, the percentage of injured apples is as high now as it was 20 years ago. This takes no account either of the greater frequency of arsenate spraying or the increased volumes of spray used per tree and application, or of the fact that doses of the insecticide average today 3 lb./100 gal., whereas formerly 2 lb./100 gal. was adequate.

Valuable lessons have been learnt from the failure of DDT to control houseflies. Not least of these is that the periodic changing of the pesticide may not suppress a DDT-resistant strain. Field trials show conclusively that flies which have become resistant to DDT are more easily able to tolerate other polychlor poisons, and that they become tolerant more quickly than strains never before exposed to insecticides.

Acquired resistance by houseflies

In a dairy where DDT resistance had developed among the flies, methoxychlor, synergised purethrine, dieldrin and pure gamma BHC were tried one after the other, during three fruitless years of effort, to bring this infestation under control. When tested in the laboratory, this strain, compared with normal stock, showed the following approximate order of resistance to insecticides: DDT 8, methoxychlor 4, chlordane 4, toxaphene 8, lindane 8, dieldrin and aldrin greater than 16, the resistance figure for normal stock being one in each case. Of additional interest is the fact that, although the flies had not been exposed to toxaphene, chlordane or aldrin, they had formed a resistance to these three insecticides.

Inherited resistance

Studies in the laboratory show that the loss of DDT resistance is inconsistent among resistant strains no longer exposed to the poison. In some cases as many as 35 generations of flies have been reared without appreciable loss, although in other instances there was a marked fall in resistance after only 10 generations had been reared in DDT-free conditions. No matter how easy it may be to rear flies in poison-free cages, in the field it is impossible to prevent the insects coming into contact with small doses of a poison once the chemical has been used. Thus it is unwise to bank on wild resistant strains losing their tolerance simply because no insecticides have been used for several months in any area.

DDT-resistant flies are helping entomologists to learn more about the vital processes of insect life.

Resistant and susceptible flies differ slightly in size, body proportions, length of life cycle, and in the relative thicknesses of various parts of the cuticle, but the most recent studies show none of these factors has any bearing on insecticide tolerance. Resistant flies lay eggs which turn into resistant larvae, and it seems that these maggots may deal with DDT in the same way as the adults.

Tolerant flies absorb DDT slowly, and they quickly change it into a non-toxic form; when the poison is fed orally the DDT is made harmless by the cells lining the gut; when it is placed on the cuticle the insecticide is detoxicated by cells immediately under this protective layer. Susceptible flies absorb DDT very much more rapidly, but are unable to destroy the poison as quickly as do tolerant flies, thus there is time for the toxin to reach the nervous system, where it produces changes that reveal themselves as the typical signs of DDT poisoning.

Chemical changes

Chemical evidence rather points to the side chain group $—CCl_3$ of DDT being changed by resistant flies into $—CHCl_2$ to form a harmless molecule. As a possible further step in detoxication, this side chain may also be changed to —COOH, but as yet there is only doubtful evidence of this occurring. It is possible that, because of their chemical resemblance to DDT, methoxychlor and Rothane D3 may be tolerated by DDT-resistant strains.

Breeding resistance

Breeding experiments show that polychlor resistance is inheritable, although at the moment it seems that no simple explanation along Mendelian lines is adequate. Such trials, however, throw some light on what happens when a colony of susceptible flies is entered by a few resistant individuals. A female having a high DDT tolerance was crossed with a susceptible male; of the 117 progeny, 90% were moderately resistant, 4½% showed high resistance and the rest were like the father. When for two generations the total stock was allowed to interbreed at random, 73% of the flies had moderate tolerance and 2.7% high resistance to DDT. In nature flies may migrate 10 to 15 miles from the place where they were reared, thus there is a real possibility that a resistant colony may be a centre from which the dispersion of the quality 'resistance' occurs.

Much of the evidence concerning the resistance of insects is conflicting and at

present no useful purpose would be served by extending this review. The literature on the subject is fully considered in two recent USDA publications and it appears that many of our opinions will have to be profoundly altered as and when new facts become available.

ALAN GOODMAN

DDT and the Older Insecticides

IN the past two years modern synthetic insecticides have incurred more public criticism than praise. In the United States a violent press attack against DDT led to public enquiries about its dangers and last year in England parliamentary discussions in both Houses have included violent attacks upon DDT among other chemicals used in food production and food processing. Nothing is more important than a sense of objectivity in assessing the merits and demerits of modern agricultural chemicals, and it is to be regretted that today, on both sides of the Atlantic, alarmism secures space and headlines in the popular press more readily than balanced accounts of pros and cons. One-sided reportage is an enemy of progress in all subjects, but in essentially scientific subjects it is disastrous. A case can always be presented against the use of any toxic material in crop protection. Fair judgment must take into account two other considerations: (*a*) the amount of food that would be lost if the substance was not used to control pests, and (*b*) whether there is any less toxic substance or method of production that could similarly prevent loss of crop. Only then can the risk of toxic residues be properly assessed.

Some interesting figures from America put the DDT problem into a much clearer perspective. In the Yakima Valley, Washington, an important apple-growing area, these are the annual figures from 1945-48 for insecticide use:

	Lead Arsenate Lb.	*Cryolite Lb.*	*50% DDT Lb.*
1945..	3,942,000	6,744,000	700
1946..	6,121,000	5,573,000	673,000
1947..	92,335	398,000	2,613,000
1948..	24,640	87,325	1,825,000

Much better control of codling moth has been secured by DDT sprays; so much so that the average number of sprayings per year has been reduced from seven to four. The crop losses to codling moth have been brought down from 15% of crop value to under 5%. Headlines may tell the public that DDT is poisoning them, but in fact the introduction of DDT has not only reduced crop wastage but has reduced the total poundage of poisonous substances required. Both lead arsenate and cryolite are toxically residual, though it can be said that the danger with cryolite is less than with arsenate or DDT. It will be noted that in 1945 in this single fruit-growing district more than 10,000,000 lb. of arsenate and cryolite were totally used; by 1948 under 2,000,000 lb. of 50% DDT were needed and only a little more than 100,000 lb. of the older insecticides. In short and alarmist accounts in the newspapers the public are told that 'more and more chemicals are adulterating their food.' Yet in truth it is a case of less and less.

Admittedly this does not dispose of the argument that small amounts of a new substance may be as toxic or even more toxic than larger amounts of older-known substances. This is the real crux of the problem. The toxicities of all these plant-protecting chemicals must be carefully studied and maximum legal standards for their presence on or in foods must be laid down. Crop-spraying programmes should be carried out so that there is no risk of these maximum tolerances being exceeded. This is the path to genuine public safety. Impassioned attacks upon DDT and other modern insecticides and demands for their abolition mean less and less food for an increasingly populated world.

Notes from France

(By our Paris Correspondent)

Afforestation plans

The importance of afforestation in France has been stressed by the Ministry of Agriculture. A special meeting was recently called, when the following figures were given:

Some 70,000 hectares are being replanted annually and between 1947 and 1950 some 236,625 hectares were replanted. The total planting programme includes 700,000 hectares of land ravaged by fire, war or pests to be forested, 400,000 hectares of land abandoned by agriculture to be included in the afforestation programme, 800,000 hectares of scrubland to be improved, and 100,000 hectares of poplars to be given attention.

The present position was summed up as follows: France is self-sufficient in wood supplies for fuel and also in certain hardwoods, but she lacks certain resinous woods. Imports of the latter amount to 300,000 cubic metres annually, together with 700,000 cubic metres for the manufacture of pulp.

The 1950 afforestation plan drawn up by the Ministry of Agriculture included the planting of maritime pines (45%), other pines (26%), Douglas firs (16%), poplars (8%) and various other types, including brushwood (5%).

Great attention is being paid to the growing of poplars, which reach maturity fairly rapidly and are in demand by industry. Likewise, a special commission has been studying chestnuts and selected two types capable of withstanding parasites. Commissions were sent to Spain, Switzerland and Italy, where considerable damage was done to chestnuts by parasites. Similar studies are being carried out on walnut trees.

Attention is also being paid to forest fires and it is hoped that precautions now being taken will reduce the possibilities of such fires spreading. Apart from the usual telephonic communications which will be speeded up in the event of a forest fire, brushwood is to be planted in single rows and it is expected that if a fire breaks out the brushwood rows will burn and protect the trees.

Ministry aid to farmers

The French Minister of Agriculture, in a recent statement, said France was fully aware of the problems facing Europe in relation to food and agriculture. He said that the policy was to lay down a long-term programme and hoped that the increase of 25% in agriculture, as demanded by OEEC, would not be too difficult to realise.

The French plan at the moment is to concentrate on certain aspects of the problem. For example, in those areas where wheat is difficult to grow the Government is prepared to issue farmers with selected seed which should be suitable for the area. The Ministry considers yields of less than 13.5 quintals per hectare to be below average. The specially selected seed can be exchanged against a quantity of wheat. On the other hand, co-operative producers will be subsidised to the value of £125,000 in seed if this becomes necessary.

The Ministry has also announced that it is prepared to subsidise co-operatives in barley to the value equivalent to £50,000 and in hybrid maize to the value of £120,000. Farmers will also be subsidised to the value of 30% of the price of spraying machines for weed control.

Ignorance of fertiliser use is to be fought by means of publicity and demonstrations in those districts where it is considered necessary and a subsidy to the equivalent value of £2½ million will be granted in order to keep the price of fertilisers at an economic level for farmers.

Other subsidies to be granted include three milliard francs (£3 million) for the purchase of regular farming equipment and almost £500,000 for the construction of silos.

WORLD CROP REPORTS

WORLD

1952 sugar prospects. The sugar beet harvest now almost completed in **Europe** has been a surprisingly satisfactory one, having regard to the fears expressed during the difficult weather conditions in the growing season. It confirms once again the fact that the sugar beet root will thrive in the wettest summer and, provided the crop is reasonably healthy, will make a good showing even with only moderate sunshine in the autumn. In Belgium virus yellows attacked the crop and had this been more general the results in Europe would have been very different. As it is, the total is but 200,000 tons below last season's record.

Little can be said at present as to probable sowings in Europe this year. There is certainly no indication of any reductions in the area and there should be every prospect of an overall increase.

Amongst the cane producers, **Cuba,** with the possibility of an increase in output this year of anything between 350,000 tons and 700,000 tons, is the outstanding feature. Only a comparatively small addition is looked for in the **Dominican Republic**, but **Mexico** will establish a new record with a promised increase of about 85,000 tons. With no sign of expansion in consumption being halted, it is unlikely that any important quantity will find its way on to the world market. **Brazil** will add to her production, but it remains to be seen whether she will export.

The **Philippines** are now back to full production, but the recent typhoon has done some damage to the crop, estimated at present at about 100,000 short tons, but even if this is so, production will be around the pre-war level.

Puerto Rico promises to add another 100,000 tons to her output which can only add to the surplus already produced last crop. It is true that this producer will participate in the deficits which will no doubt be declared in the **United States** later in the season, whilst it seems that the 1953 production may be restricted. Whether it will be decided to carry this surplus forward as has happened in the case of the 1951 surplus will depend on a variety of factors, not the least of which will be the trend of consumption in America, and the level of prices ruling in non-U.S. markets.

The disastrous weather conditions which have prevailed in **Australia** and **South Africa** and which have seriously curtailed the crops now being harvested, will no doubt be reflected in the coming season. Coming at a time of grave economic stress in this country this serious setback in Australia is most unfortunate, for that country had at one time expected a total crop of around 1 million tons. As to South Africa, the industry will be hard put to it to satisfy internal demands between now and the time new crop sugars become available.

The two one-time heavy producers in the Far East, namely, **Indonesia** and **Formosa**, are making only very modest progress towards recovery. The 125,000 tons more expected from the former island will practically all be consumed at home and in the surrounding islands; whilst Formosa now expects to produce no more than 500,000 tons, or 100,000 tons over last season's total.

(From Czarnikow's 'Sugar.')

Barley and oats, 1951. World production of barley and oats during 1951 is now estimated at 130 million short tons, one of the largest harvests on record, according to the U.S. Department of Agriculture. The yield compares with the 1950 figure of nearly 125 million tons and the 1935-39 average of 126.5 million.

The 1951 tonnage comprised 2,580 million bushels of barley and 4,270 million bushels of oats, with much of the increase over 1950 occurring in the deficit areas of Europe and Asia.

Barley production in 1951 was well above the pre-war average with expansion most marked in Canada. Declines in the oats crops of Europe, and apparently the Soviet Union, which more than offset the increased production in North America, accounted for lower levels compared with pre-war.

PAKISTAN

1951-52 cotton estimate. The second forecast of the area under cotton crop for the year 1951-52 is 3,070,000 acres (American 2,747,000 acres and Desi 323,000 acres), as against 2,881,000 acres (American 2,551,000 acres and Desi 330,000 acres) reported in the second forecast of the previous year, and shows an increase of 6.6%. The increase in respect of American varieties is 7.7%, but in respect of Desi varieties there is a decrease of 2.1%.

There has been a general increase in the acreage of this crop throughout Pakistan, attributed to favourable weather conditions at the time of sowing and also to the high market prices. Sowing commenced on normal dates.

U.S.A.

Tobacco production and exports. The estimate for the 1951 crop has undergone a revision upward to 2,271.7 million lb., mainly because the Burley estimate has been increased to 580.9 million lb. and that of East North Carolina flue-cured (Type 12) to 490.7 million lb.

Unmanufactured tobacco exports in September 1951 reached the exceptionally high figure of 74.6 million lb., of which 52.9 million lb. were flue-cured consignments to the United Kingdom.

AUSTRALIA

Prospects for jute and jute substitutes. Efforts are being made to expand the growing of jute and jute substitutes in Australian territories so that the country will be less dependent upon outside sources, reports our Australian correspondent. Assistant general manager H. N. Giles of Elder Smith & Co. Ltd. said: 'Australia has always been dependent on India for jute supplies, and has used about 120,000 tons annually. Owing to the partition of India and Pakistan, however, there are doubts as to the continuance of full supplies. Last year Australian wool realised over £600 million and it is hardly necessary to emphasise how important the jute industry is to Australia, and what would happen if the necessary wool packs were not obtainable. The growing of bast fibre plants in New Guinea was first recommended by Mr. R. A. Colyer, of Sydney, and was taken up by the Department of External affairs. Test plantings have been successfully carried out at widely separated points, and in several instances experts have agreed that the plantings were equal to, and in a few cases better then, those grown overseas. All the work done so far in New Guinea is experimental, but the progress made inspires hope that Australia's fibre requirements will one day be supplied from the New Guinea fields.'

The future of flax. Excessive rains at sowing time have reduced the acreage of flax in Western Australia this season, reports our Australian correspondent, and plantings in Victoria and South Australia are also well down. It is expected, however, that next season's crops will be solidly increased. Recently, flax growing in most parts of Australia has been in competition with wool, but now that wool prices show signs of declining it is likely that more land will be available for flax.

The cost of establishing a fibre industry to make Australia independent of overseas jute supplies would be about £30 million, some 300 delegates to the 58th

annual congress of the Agricultural Bureau of South Australia were recently told by the chairman of the Flax Production Committee (Mr. J. Stevenson). He added that heavy capital cost, potential competition from overseas producers, and the need for courage, wise planning and heavy protection would have to be faced before the fibre industry was begun in Australia. 'It still remains to be proved that Australia can produce raw jute or substitute fibres at a cost competitive with other countries,' he said, 'but it has been demonstrated that fibres can be produced in certain parts of Australia and New Guinea, and the position is being investigated.'

Wheat prospects. A higher yield per acre, put at 16.27 bushels, will partially offset this year's reduced Australian wheat acreage of about 10,246,000 according to the Commonwealth Statistician. He reported the acreage at 12.1% below last year and 21.1% down from the average sowings of the five years to 1938-39, but the forecast crop of 166.7 million bushels is only about 10% under last year's production of about 184 million.

ARGENTINA

January harvesting. By mid-January the **wheat** harvest was practically completed with the exception of southern Buenos Aires. **Linseed** harvesting was in full swing and preliminary estimates of total output were pessimistic—359,000 tons compared with the 1950-51 crop of 559,000 tons. This season's **Sunflower** crop, on the other hand, is estimated at approximately 1 million tons against 920,000 tons last year.

BRITISH WEST INDIES

The West India Committee has received from Governments and from Sugar Associations the following statistics regarding the West Indian sugar industry:—

	Preliminary estimates for quota year 1951-52		*Latest returns, quota year* 1950-51		
Colony	*Total production*	*Production for export*	*Total production*	*Local and neighbouring consumption*	*Production for export*
	tons	*tons*	*tons*	*tons*	*tons*
Barbados	(*a*) 180,000	(*a*) 172,000	(*b*) 187,665	8,000	(*b*) 179,665
British Guiana ..	223,583	210,401	189,768	16,000	173,814
British Honduras ..	2,928	Nil	1,580	1,580	Nil
Jamaica	283,215	229,215	267,928	54,000	213,928
Leeward Islands:					
Antigua	25,000	20,700	18,500	4,300	14,200
St. Kitts ..	45,000	42,500	44,272	2,600	41,672
Windward Islands:					
Grenada	3,250	Not available	2,800	2,758	253
St. Lucia	8,700	6,901	9,825	1,800	8,023
St. Vincent ..	3,000	1,000	2,792	2,092	700
Trinidad and Tobago	168,600	145,600	140,673	23,000	117,688
Total ..	943,276	(*c*) 828,317	865,803	116,130	749,943

Note.—Barbados: (*a*) Includes fancy molasses; (*b*) includes 23,100 tons fancy molasses; (*c*) excludes figure for Grenada.

(*From the West India Committee Circular.*)

BRAZIL

Carnauba wax. Brazil's carnauba wax output in 1951-52 is estimated at 12,700 short tons, an increase of 600 tons from the first estimate for the season. Production in 1950-51 and 1949-50 was 12,570 and 12,280 tons respectively. The yield from the first cuttings has confirmed the earlier prediction that the drought conditions prevailing in North-East Brazil have favoured a higher yield per frond. (*Foreign Crops and Markets.*)

Fourth biggest tobacco producer. Among the tobacco-producing countries of the world Brazil occupies the fourth place, after the United States, China, and India, with a production which has risen from about 200 million lb. per annum in the immediate pre-war years to an average of some 250 million lb. per annum in the post-war period. Tobacco production is carried on in almost every State of Brazil, but Rio Grande do Sul and Bahia together still account for over half of the total, followed by Minas Gerais and Santa Catarina, production in the last-named State having shown the most marked expansion. Brazil's great diversity of soils and climates makes possible the cultivation of a wide range of types of leaf, although no official figures of production by varieties are available. In general, however, the northern States produce mainly air-cured, dark, cigar-types, Bahia in particular having long been noted for its production of cigar leaf. In the southern States on the other hand, light air-cured types (rather resembling the Burley of the United States) predominate; the production of flue-cured types, introduced into Rio Grande do Sul in 1932-33 and into Santa Catarina in 1945-46, now, however, falls little if at all short of 50 million lb. per annum in these two States combined, having thus shown a fourfold increase over the average of the immediate pre-war years. Brazil's total production of tobacco reached its maximum of some 263 million lb. in 1946, but since then production has shown a downward trend, partly owing to the difficulty of finding adequate market abroad. Total acreage and production figures since 1937 have been as follows:—

BRAZIL: TOBACCO AREA AND PRODUCTION

	Area (thousand acres)	*Production (thousand lb., wet weight)*
1937 ..	253	184,397
1938 ..	227	200,841
1939 ..	230	211,637
1940 ..	238	208,926
1941 ..	238	210,180
1942 ..	238	204,920
1943 ..	251	201,811
1944 ..	284	230,079
1945 ..	355	250,110
1946 ..	337	262,843
1947 ..	332	244,466
1948 ..	356	259,320
1949 ..	359	252,436
1950 ..	351	234,510

(*From the Commonwealth Economic Committee's 'Tobacco Intelligence.'*)

INDIA

An average black pepper crop. The 1952 black pepper crop in India is estimated at between 20,000 and 22,000 tons, which would be around average levels. The new crop in the Far East is expected to furnish an additional 8,000 to 10,000 tons of black pepper for international trade.

A leading Bombay black pepper firm, in a review of the 1950-51 year, says that India exported nearly 15,000 tons from its estimated crop of 20,000 tons. With the exception of Russia, which stepped up her purchases to about 1,000 tons, the pattern of exports followed closely that of the previous year. The U.S. took nearly 9,000 tons, while the U.K. took some 2,000 tons. According to this firm, these exports were made at an average price of 1.60 dollars a lb.

INDONESIA

Largest copra exports since pre-war. Indonesian exports of 29,625 long tons of copra during December bring the total for 1951 to 455,483 tons. This is the largest annual volume of shipments since pre-war and represents an increase of over 90% from the 238,075 tons exported in 1950.

Preliminary data for December indicate that the Netherlands purchased 21,376 tons, Austria 3,000 tons, Sweden 2,625 tons, and Denmark 2,624 tons. Revised figures for November were as follows: The Netherlands, 22,018 tons; Norway, 5,249 tons; Denmark, 8,748 tons; a total of 36,015 tons.